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Contents.

	PAGE
An Unqualified Success	29
An American Development in High-Grade Iron Alloys	30
Sheffield Convention Subscription List	30
America Joins International Committee	30
Suggested Federation of Iron and Steel Merchants	30
European Ferro-Silicon Syndicate	30
Institute of British Foundrymen—Twenty-fourth Annual Convention	31
On the Effect of Nickel and Chromium on the Strength Properties of Grey Cast Iron	37
The Influence of Manganese and Manganese Sulphide on Whiteheart Malleable	41
Book Review	44
Foundrymen Want to Know	44
The Manufacture of a Large Steel Casting	45
Company Meetings	48
The Importance of Air Control in Efficient Cupola Practice	49
Trade Talk	56
New Companies	56
Personal	56
Contracts Open	56
Iron and Steel Markets	58
Catalogues Received	58

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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Secretary: K. S. Bridges, Avenue Chambers, Southampton Row, London, W.C.1.

Welsh Engineers' and Founders' Association.
Secretary: F. J. Griffiths, 20, Fisher Street, Swansea.

An Unqualified Success.

The Annual Convention of the Institute of British Foundrymen, which took place last week in Sheffield, was notable in many directions. Primarily it was the largest Convention ever held unassociated with an exhibition. The quality of the Papers reached a higher standard than has ever been associated with British foundry practice. The announcement by Professor Piwowarsky that an alloy cast iron—but still a cast iron—had been made, showing 47 tons per square inch tensile, having many other excellent properties was perhaps of an epoch-making character. Naturally the experiments were of the usual small-scale variety, but some of the principles disclosed are readily translated into practice, and British industry will eagerly await their confirmation and elaboration.

The foundry industry is deeply indebted to the great industrial concerns of Sheffield for breaking down tradition and opening their shops freely for inspection. The new foundry at Cammell, Laird & Company was justly appreciated for its admirable lay out, whilst the variety and quality of workmanship of the castings made in the shops of Edgar Allen was highly praised by the visitors. The vast iron foundry of Newton Chambers, specialising as it does in cast iron houses and centrifugal castings, drew a large number of visitors, who were impressed with the unqualified success achieved. At Vickers, Limited, the guests were quickly made to realise that but few firms in the world possessed such wonderful handling facilities, and later viewed with apprehension the competition which drop-stampings were putting up against castings. The founder in asking the designer to simplify shape has pointed the way for an alternative and cheaper method of manufacture. Members who visited the Brown-Firth Research Laboratory met in Dr. Hatfield, its director, one of the few metallurgists who has justly earned a world-wide reputation as both a cast iron and steel expert. His sympathy with the foundry point of view enhanced considerably the undoubted value of such a visit. At Davy Brothers foundrymen visited what could be adequately termed the heavy plant constructing department of Sheffield's steelworks, whilst the works of Samuel Osborn & Company, Limited, is a combination of tool steel factory and a steel foundry, and thus naturally the visitors expected to see, and were not disappointed, the correct utilisation of tool steel in the various foundry departments.

On behalf of the foundry industry we express their thanks to the civic authorities, the Cutlers' Company and the University, and in connection with the last, especially to Dr. Desch, who personally did so much to ensure the comfort of the visitors. Additionally, Mr. Macdonald the Convention secretary deserves unstinted praise for controlling so efficiently the complicated machinery necessary to ensure the smooth working of the most successful of these ever-growing annual conventions. Finally, we congratulate Mr. John Goodwin on his election, which is a fitting reward for a man who has devoted so much time and work to promotion of technical and social side of the foundry industry. The type of work which he controls at Sheepbridge, that is, the manufacture of cast-iron pipe and the heaviest castings, has only been once previously represented by the occupant of the presidential chair. It is all to the good that each section of the industry should in turn be called upon to preside over the destinies of the Institute so that every shade of opinion may be represented. Undoubtedly for this industry no better representative could have been chosen.

An American Development in High-Grade Cast Iron Alloys.

During the past two years the Q & C Company, of 90, West Street, New York, has been doing considerable development work in an effort to obtain a commercial iron that would not warp or twist under temperatures encountered in locomotive grate service. This experimental work has finally resulted in the development of an alloy cast iron which is being placed on the market under the trade name of Nogroth metal. Nogroth metal is an air furnace product. Its structure resembles that of white cast iron and has many of the properties of cast steel. It has, however a number of physical properties different from that of cast iron, in that it retains its original strength at high temperatures, nor will it grow when exposed to temperatures below the melting point; that is, the metal will not acquire a permanent expansion when subject to high temperatures.

Four specimens of Nogroth metal from different heats were recently subjected to laboratory physical tests. The yield point of this metal is about 15 tons per sq. in., and the ultimate strength is approximately 32.5 tons. The ductility of this metal is indicated by the elongation of 6 per cent. in 2 in. shown for three of the four test specimens, the other being 5.5 per cent. Additional evidence of the ductility of Nogroth metal is shown from a test specimen which was placed in a vice and bent cold to about 40 degs. before breaking.

Locomotive parts of Nogroth metal, such as grate bars, are cast in the same manner as when the parts are made of cast iron, except that the Nogroth metal is heat treated after it has been removed from the mould. By varying the character of the heat treatment, the Brinell harness may be varied from 200 to somewhat above 550. Parts made of the softer grades of Nogroth metal are easily machined. The tensile strength of unheat treated Nogroth metal is about 22.3 per sq. in., the other physical properties being the same as that of high-grade cast iron.

Sheffield Convention Subscription List.

Since publishing the last list of subscriptions to the Sheffield Convention Fund, the following have been received:—

Messrs. Hadfields, Limited, £25; Messrs. J. W. Jackman & Company, Limited, £5 5s.; Messrs. Fordath Engineering Company, Limited, £10 10s.; Messrs. J. Grayson, Lowood & Company, Limited, £5 5s.; Messrs. Newton, Chambers & Company, Limited, £20; Messrs. Penton Publishing Company, Limited, £2 2s.; Messrs. Vickers, Limited, £25; Messrs. John Brown & Company, Limited, £10s.

With reference to the amount of £10 from Messrs. Cammell, Laird, published in our last issue, this should be £15. This was the amount originally promised, but the actual cheque was £15.

America Joins International Committee.

It has been learnt with a considerable amount of gratitude by the European foundrymen's associations that, M. Paul Ropsy, the President, has received a letter from Mr. H. Cole Estep, the Chairman of the International Relationship Committee of the American Foundrymen's Association, that America has decided to participate in the work of the International Foundrymen's Committee. They have asked Mr. Vincent Delport to be their representative.

We regret to record the death of Madame Veuve Theret, a prominent foundry owner in the Ardennes region of France.

The well-known American foundry equipment firm of J. W. Paxson has been taken over so far as these lines are concerned by the Titgen-Eastwood Company, of Philadelphia, Pa.

Suggested Federation of Iron and Steel Merchants.

MR. FRANK BAXTER, of Baxter, Fell & Company, iron, steel, metal and hardware merchants, 36, Leadenhall Street, London, E.C.3, writes on an aspect of the merchant side of the iron and steel industry which is of considerable importance. He states:—

"To those who have followed closely the recent inquiry into the application of the National Federation of Iron and Steel Manufacturers for the marking of foreign steel, it must have been clearly shown to them the necessity for a corresponding Federation of Iron and Steel Merchants and Stockholders.

"The small amount which I was privileged to do in connection with the opposition to this application brought home to me very vividly the difficulty of bringing quickly to the notice of those interested the nature and importance of the application. In my opinion, there was an under-current of antagonism to, or of complete disregard for, the merchant and stockholder. His interests were neither consulted nor studied, and arrangements were made during the course of the inquiry which were directly in opposition to the interests of those whom I think should form a national association. I have not had long enough experience in the trade to know whether such movements have been attempted before, but, if so, they have apparently failed, and I feel that if an association were formed, whose primary and only objects were:—

"(1) Political,
"(2) Legal,
"(3) Economic,

and no effort or suggestion was made that the proposed association should deal with subjects outside the above, such an association would be lasting and valuable to the trade.

"The time has come when some central organisation should be formed, to watch the interest of our trade from the above three standpoints, and attacks should be at once resisted with the full force of this national association.

"If the movement were widespread, the cost of membership need not be very large, and funds should be easily sufficient to cover the cost of employing a political agent and a barrister, whose sole duties would be to bring to the notice of the association movements and questions which vitally affect the interests of its members."

European Ferro-Silicon Syndicate.

A recent statement issued by Commercial Councillor Henry Rosenbaum, of Vienna, confirms the reports that have been current for some time past regarding the formation of a syndicate of European makers of ferro-silicon. Herr Rosenbaum himself has been elected general director of the new combine. The date of the agreement is given as June 15 last.

Referring to the keen price-cutting that prevailed among makers in the early days of the negotiations, due probably to their desire to receive favourable quotas in the allotments, the statement goes on to remark upon the impossibility of taking such prices (which were below the cost of production) as a basis of comparison with the prices to prevail after the formation of the syndicate. Their continuance would practically ruin every existing ferro-silicon works. In the different countries the wholesale commerce index numbers range between 40 to 70 per cent. above the price level in 1914. These index numbers, which represent averages of all conceivable figures and products, cannot be taken as a guide for the calculation of the price of ferro-silicon, as the prices of raw materials, such as coal, turnings and even quartz, have increased to a materially greater extent; wages have also largely risen, and the cost of electrical energy more especially is a far more important factor in the calculation of the costs of production than it had been in pre-war days. It is also impossible to leave out of account the great advance in the railway rates for the transport of raw and auxiliary materials.

Iron and Steel Output.

At the end of June the number of furnaces in blast in Great Britain was 175, a net decrease of nine since the beginning of the month. The production of pig-iron in June amounted to 650,500 tons, compared with 720,100 tons in May and 680,000 tons in April. The production includes 219,300 tons of hematite, 216,300 tons of basic, 167,400 tons of foundry, and 23,100 tons of forge pig-iron.

The production of steel ingots and castings amounted to 747,300 tons in June, compared with 884,600 tons in May and 850,100 tons in April.

INSTITUTE OF BRITISH FOUNDRYMEN.

TWENTY-FOURTH ANNUAL CONVENTION.

The twenty-fourth annual meeting and conference of the Institute of British Foundrymen was held in Sheffield from Tuesday to Friday, July 5 to 8, under the presidency of Mr. J. T. Goodwin, M.B.E., M.I.Mech.E., of the Sheepbridge Coal and Iron Company, Limited There were present more than 300 members and visitors, the latter including representatives of foundrymen's associations in foreign countries, and many ladies. An excellent programme was provided for their instruction and enjoyment, which included the reading and discussion of papers, visits to works and social functions, and, as usual, a feature of the programme was the excellent manner in which the interests of the ladies were catered for.

TUESDAY, JULY 5.

On Tuesday evening the members and visitors attended a reception at the Cutlers' Hall, at the invitation of the Master and Mistress Cutler (Mr. and Mrs. David Flather), and spent an enjoyable evening, renewing old friendships and making new ones. Dancing was also a feature of the evening's programme.

WEDNESDAY, JULY 6.

Thanks to the courtesy of the Sheffield University authorities, the meetings were held in the Mappin Hall at the Department of Applied Science, at St. George's Square, and the members assembled there on Wednesday morning, when a cordial welcome was extended to them on behalf of the city and of the University by the Lord Mayor (Alderman J. G. Graves, J.P.) and the Vice-Chancellor of the University (Sir Henry Hadow, C.B.E., M.A., D.Mus., LL.D., J.P.) respectively.

MR. V. C. FAULKNER (the retiring president) occupied the chair during the early proceedings, and the duty of introducing the Lord Mayor and the Vice-Chancellor devolved upon him. It gave him very great pleasure, he said, to speak in that hall, where he had made, perhaps, his first speech to a metallurgical audience, some twenty years ago, and it was with a feeling of personal satisfaction that he found himself in his present position, addressing a national and even an international audience of foundrymen. In asking the Lord Mayor to address the meeting, he said he would like him to know that the audience, while cognisant of, and grateful for, the wonderful facilities which were provided by the City of Sheffield—of which the Lord Mayor was so distinguished a head—in the way of transport, sanitary and other services, which services were so very efficient, they did view with alarm the cost which those facilities imposed upon their industry. It was said that the rates of Sheffield were costing the steel industry something like 10s. per ton, as against a very few shillings per ton in pre-war days. Speaking of the industrial importance of Sheffield, he said that not only was it a great iron founding centre, but it was also a very important steel founding centre—actually the most important in Europe. The non-ferrous foundry industry, however, was but sparsely represented in this great city.

THE LORD MAYOR said he accepted Mr. Faulkner's invitation with very great pleasure indeed, for he felt particularly proud to act upon this occasion as the spokesman of the city. He always felt that he had the whole of the citizens of this great community behind him when offering a welcome to visitors, may be to strangers, to the city. They did feel very proud indeed that the Institute had chosen Sheffield as the venue for its conference; he was sure that the conference would be very successful and very pleasant, and hoped that the members of the Institute and the visitors would learn much of the great resources of the city, that they would cement old friendships and form new ones, that they would find fresh interests while in Sheffield, and that they would see a good deal of its beautiful surroundings. Mr. Faulkner had rather put the wind up him by his abrupt and unexpected reference to realities. Wise Lord Mayors restricted their speeches on these occasions as far as possible to pleasant generalities, and occasionally indulged in platitudes, but they made as little reference to rates as they possibly could. Therefore, he would get over that point as quickly as possible. (Laughter.) Finally, he expressed the hope that he might have many opportunities of meeting other members of the conference, that their contact might be extremely pleasant to them all, and that they would carry away from the city very pleasant recollections of the nineteen twenty-seven conference.

MR. JOHN T. GOODWIN
(the recently elected President of the Institute of British Foundrymen).

Mr. Goodwin, who for the last 19 years has been general manager of the foundries and engineering departments of the Sheepbridge Coal & Iron Company, Limited, of Chesterfield, was trained originally at the Butterley Works. After spending some time on the North-East Coast he returned to Derbyshire to take up his present position. During the war he erected a factory for the complete manufacture of shells for the Admiralty up to 15 ins. diameter. He was at that time Captain of the Northern Command of the Derbyshire Motor Transport Corps, and in recognition of his services he received the M.B.E. He has been a member of the Institute since 1905. He is also a member of the Institute of Mechanical Engineers, the Iron and Steel Institute, and the Institute of Metals. He has read several papers before the Institute, and this year is to present a paper before the Association Technique du Fonderie in Paris in September.

MR. FAULKNER, inviting the Vice-Chancellor to address the conference, said that foundrymen throughout the world were deeply indebted to the University of Sheffield for the character of the men it had turned out, and also for the uniform excellence of the researches, the results of which it had placed at the disposal of the metallurgical world. The members of the Institute of British Foundrymen appreciated very highly the wonderful research work which was turned out under the ægis of their esteemed fellow member, Professor C. H. Desch (Professor of Metallurgy at the University). He (Mr. Faulkner) knew the Department perhaps as well as anybody; he was one of the students there when it was turned into a University, and he assured the Vice-Chancellor that he had never lost his interest in the work of that Department, which was still recognised as the centre of steel thought throughout the whole world.

SIR HENRY HADOW, in his welcome to the members, said it always gave him great pleasure, as a representative of the University, to stand on a public platform with his very good friend, and,

if he might say so, his colleague, the Lord Mayor, who represented the City; he was very glad to see representatives of the City and the University side by side on any public platform. The Institute of British Foundrymen, he continued, was specially connected with the University. For one thing, one of the founders of the Institute was Dr. P. Longmuir, whom the University was proud to number among its Graduates. For another thing, one of the chief branches of the Institute was at Glasgow and another was at Sheffield, and if one added the three words "Glasgow," "Sheffield" and "Metallurgy" together, the sum total was "Prof. Desch." Again, the Institute had had very great success; its President, Mr. Faulkner, was a member of the University, and a member whose career was watched with very great interest and pride. The University authorities congratulated him upon his year of office, and they wished all success to Mr. Goodwin; they welcomed the Institute particularly because they were always very glad to see institutes which had a great scientific background and a scientific basis, and because the science of the Institute was one with which the University and the Applied Science Department were specially and intimately concerned. He hoped the visit would be pleasant and profitable, and assured the members that if the University authorities could do anything to aid the conference or make the business more pleasant, they would do their utmost. All the services at the University were at the disposal of the Institute.

Presentation of "Oliver Stubbs" Gold Medal.

The "Oliver Stubbs" Gold Medal, which is provided from funds supplied by the Iron Founding Employers' Federation, and awarded each year for distinguished services to iron founding and to the Institute, was presented by the Lord Mayor to Professor T. Turner (Emeritus Professor of Metallurgy at Birmingham University, and a Past-President of the Institute of Metals).

MR. FAULKNER said that iron founders in particular were indebted to Professor Turner because he had shown the world how silicon influenced the general structure of cast iron. His research, which was done many years ago, had had an enormous influence on every foundry. There were some 3,000 iron foundries in Great Britain and probably 20,000 throughout the world, and they all used the results of the research of Professor Turner—some unwittingly and some knowingly.

PROFESSOR TURNER, returning thanks, said he had worked for many years in connection with the foundry in various ways, he had formed many friendships and had had many interests; the medal would be a lasting connection and a remembrance to him and his family of work which had been a pleasure whilst it was being performed, and which he trusted had been of some use to others.

Presentation to Mr. John Shaw.

A handsome hall clock was presented to Mr. John Shaw (late manager of the foundry of the Brightside Foundry & Engineering Company, of Sheffield, and who recently retired) by members of the Sheffield Branch and other members of the Institute in recognition of his services to foundrymen. It was intimated by Mr. Faulkner that Mr. Shaw had had a very long and distinguished career, and had placed his experience most generously at the service of foundrymen. During the war he was Controller of Cast Iron at the Ministry of Munitions, and in that capacity had shown a very clear sense of what was just and equitable for the founders.

(The clock, which stood about 5 ft. 6 in. high, was inscribed:—"Presented to Mr. John Shaw by members of the Sheffield Branch and other members of the Institute of British Foundrymen in recognition of his eminent services to the Institute. Sheffield Convention, 1927.")

MR. SHAW, in expressing his appreciation of the gift, which was a complete surprise to him, generously remarked that anything he had done had been for his own good as well as for the good of the Institute; he owed practically everything to the friendships he had made in the Institute. He also acknowledged the cordial relations which had always existed between himself and his colleagues, and in this connection he mentioned specially Prof. C. H. Desch, Dr. W. H. Hatfield and Dr. T. Swinden. He thanked them all for the help they had extended to him at all times.

Vote of Thanks to Lord Mayor and Vice-Chancellor.

MR. FAULKNER proposed a hearty vote of thanks to the Lord Mayor and Sir Henry Hadow for the charming welcome they had extended to the members, and expressed appreciation of the kindness of the University authorities in placing the facilities of the University at the disposal of the Institute. He hoped that as the result of the Conference the foundry owners, managers and employees throughout Great Britain would learn to know and appreciate Sheffield and its University much better than they had done in the past, although he appreciated, of course, that their reputation was very high throughout the whole metallurgical world.

The vote of thanks was accorded with acclamation, and the Lord Mayor and Vice-Chancellor withdrew.

Annual General Meeting.

The business of the annual general meeting of the Institute was then proceeded with. The minutes of the last annual general meeting were taken as read, and were confirmed and signed and the Annual Report submitted.

Annual Report of the General Council for the Session, 1926-27.

The General Council has pleasure in presenting to the Members of the Institute the Report of the work during the Session 1926-27.

The total number of members on the roll of the Institute on April 30 was 1636. The Council regret to announce the death of 14 members during the year. The distribution of the membership among the various branches is shown in the following table:—

	Subscribing Firms.	Members.	Associate Members.	Associates.	Total.
Birmingham, Coventry, and West Midlands ..	2 (1)	68 (71)	106 (122)	16 (22)	192 (216)
East Midlands	—	34 (31)	57 (52)	4 (5)	95 (88)
Lancashire	9 (8)	108 (95)	193 (187)	8 (8)	318 (298)
London	2 (2)	112 (90)	82 (77)	8 (10)	204 (179)
Middlesbrough	4 (2)	26 (17)	27 (19)	8 (7)	65 (45)
Newcastle	10 (10)	67 (66)	60 (72)	72 (88)	209 (236)
Scottish	—	54 (50)	115 (89)	30 (11)	199 (183)
Sheffield	6 (6)	81 (77)	96 (89)	13 (11)	196 (183)
West Riding of Yorkshire	—	25 (28)	53 (45)	2 (2)	80 (75)
Wales and Monmouth ..	—	17 (18)	12 (12)	4 (3)	33 (33)
General	—	32 (26)	12 (3)	1 (—)	45 (29)
Total	33 (29)	624 (569)	813 (794)	166 (186)	1,636 (1,574)

The figures in brackets are for the Session 1925–1926.

The new branch which was opened at Middlesbrough during the spring of last year has now completed a very successful first session and is still adding to its membership.

Junior Sections.—The junior sections in connection with the Newcastle and Lancashire Branches continue to make good progress. The London and Birmingham Branches have also inaugurated successful junior sections and the formation of similar sections is under consideration by other branches.

Oliver Stubbs Gold Medal.—The fifth medal was awarded to Mr. A. R. Bartlett, of Belvedere,

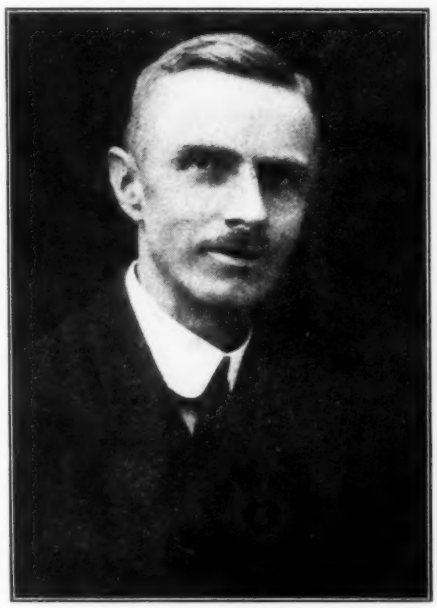
Kent, for meritorious services rendered to the Institute over a period of many years.

Diplomas.—Six diplomas have been awarded for Papers which have been given before the branches. The recipients and the respective branches before which the Papers were given are as follows:—J. Longden, Scottish Branch; Major K. C. Appleyard, Newcastle Branch; J. R. Hyde, Sheffield Branch; A. J. Richman, Lancashire Branch; W. West, Burnley Section of Lancashire Branch; M. J. Cooper, London Branch.

Annual Conference, 1926.—The 1926 Annual Conference was held at the Royal Agricultural Hall, London, in June, and in spite of the unsettled industrial conditions prevailing at that time and of the difficulties of travelling, the Conference was very successful and was largely attended. Simultaneously with the Conference a very comprehensive Foundry and Allied Trades Exhibition was held.

The next Annual Conference will be held on July 5, 6, 7 and 8, 1927, at the University, St. George's Square, Sheffield, by kind permission of the University authorities.

General Council.—Five General Council Meetings have been held at London, Manchester, York, Birmingham and London respectively. All



MR. S. H. RUSSELL
(Senior Vice-President).

Mr. Russell is a partner in the well-known firm of Messrs. S. Russell & Sons, ironfounders and engineers, of Leicester. This concern was established in 1864 by Mr. Russell's grandfather. He was educated at Wyggeston Grammar School, Leicester, and Birmingham University. He joined the Institute of British Foundrymen in 1908, and was honorary secretary for the Leicester Convention in 1914. It was largely through his efforts that the East Midlands Branch was formed. In 1923 he presided over this branch. He became actively associated with the British Cast Iron Research Association on its formation, and now serves on its council. Last autumn Mr. Russell, as vice-president, together with Mr. John Cameron (a past-president), officially represented the Institute at the International Foundrymen's Convention, held in Detroit City.

branches have been well represented at these meetings and there has been an average attendance of 34.

In accordance with the bye-laws the following members of the General Council, all of whom are eligible for re-election, retire at the General Meeting:—Messrs. W. T. Evans, A. Firth, J. Haigh, A. Harley and H. Winterton. All these gentlemen offer themselves for re-election. It is necessary to elect five members to complete the ten members elected at general meetings, as provided for in the bye-laws.

Standardisation of Test Bars.—During the year the committee of the British Engineering Standards Association, which is dealing with this matter, completed the drafting of a tentative specification for grey cast iron which followed to a great extent the lines laid down in the original specification issued by the members of your Test Bar Committee. The whole of the clauses in the B.E.S.A. Tentative Specification were accepted by the various bodies which were represented with the exception of a clause introduced at the final meeting. This clause which relates to a guaranteed time limit before the manufacturers' responsibility ceases, was opposed by your representatives and the settlement awaits a further meeting.

International Tests for Cast Iron.—Your representative, Mr. Shaw, attended an informal International Meeting at Detroit, at which a preliminary discussion on the tests in operation in various countries, took place. Your representative promised to carry out certain tests by a modified "Frémont" method, but he has not yet been able to commence these tests, as up to the present he has not received the drawings of the necessary apparatus.

British Cast-Iron Research Association.—The Institute continues to have very close relations with the British Cast Iron Research Association. In July, 1926, the Association started on its sixth year of activity with the assurance of very generous grants in aid from H.M. Government during the second five-year period of its existence. This support is conditional upon the Association

MR. W. A. MACDONALD
(Convention Secretary).

reaching an income of £4,000 per annum, and the support of all ironfounders is earnestly requested, not only to ensure this sum, but to increase it to at least £6,000 per annum, the limit up to which subscriptions will be doubled by means of the grant.

The main development since the last report was issued has been the acquisition of headquarters, offices and laboratories in one building at 24, St Paul's Square, Birmingham, thus combining the offices and laboratories hitherto separately conducted. This has resulted in many advantages and economies in working. All foundrymen interested are cordially invited to pay a visit to the headquarters.

International Relations.—In the autumn of 1926 a number of members and ladies attended the Second International Conference in Detroit, U.S.A., and the thanks of the Institute are due to the American Foundrymen's Association for their hospitality.

The Institute has accepted an invitation on behalf of its members to take part in an International Conference in Paris in September, 1927, and it is hoped that a large number of members and ladies will be present.

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The Third International Congress will be organised by this Institute and will be held in London early in June, 1929, and invitations to participate have already been issued to overseas foundry associations.

In December last your President and Secretary attended a meeting in Brussels, and as a result of this meeting an International Committee of Foundry Technical Associations was formed. This Committee will regularise the dates and arrangements for International Conference and will also be concerned with other matters of an International character which are of interest to the various foundry associations. Your General Secretary has been elected Hon. Secretary of this committee.

General Secretary.—It is with great regret that the Council report that in October last Mr. W. G. Hollinworth found it necessary to resign from the Secretaryship of the Institute on account of continued ill-health. The sympathy of the members and thanks for his devoted services have already been expressed to Mr. Hollinworth.

Mr. T. Makemson, Hon. Secretary of the Lancashire Branch, was appointed General Secretary in succession to Mr. Hollinworth, and commenced his duties on December 1, 1926.

General Offices.—The lease of the General Offices at Victoria Street, London, expired on December 25 last, and as the Council was faced with the necessity of engaging other accommodation they decided to transfer the General Offices to the provinces, and the present offices at St. John's Street Chambers, Deansgate, Manchester, were engaged. It is hoped that the removal of the General Offices to the provinces will make for more effective and economical working. By kind permission of Industrial Newspapers, Limited, arrangements have been made for their offices, 49, Wellington Street, Strand, to be the Registered Offices of the Institute.

"*Proceedings.*"—An index to the "Proceedings" from the first volume to the volume 1924-25 has been prepared and will be on sale very shortly at a nominal charge. It is hoped that all members will purchase copies of the Index and thereby enhance the value of their sets of the "Proceedings." Statement of accounts and balance sheet for the year ended December 31, 1926, follow this report. The Council is of the opinion that the usefulness of the Institute can be largely extended by an increase in the membership, and all members are respectfully urged to impress the advantage of membership upon those engaged in the foundry industry who are not yet members of the Institute.

V. C. Faulkner, *President.*
Tom Makemson, *General Secretary.*

Balance Sheet.

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED DECEMBER 31, 1926.

Expenditure.

	£	s.	d.	£	s.	d.
Postages				87	13	0
Printing and Stationery, including printing of Proceedings				591	0	3
Council, Finance and Annual Meeting Expenses				47	4	5
Medals for Past-Presidents				36	14	0
Branch Expenses:—						
Lancashire	135	12	8			
Birmingham	74	1	5			
Scottish	102	1	1			
Sheffield	67	10	5			
London	52	5	9			
East Midlands	36	19	1			
Newcastle	100	11	5			
West Riding of Yorkshire	32	18	0			
Wales and Monmouth	19	17	6			
Middlesbrough	11	2	1			
				632	19	5
Audit Fee				6	6	0
Incidental Expenses				32	9	10
Salaries—Secretary and Clerk				429	3	4
Rent of Office				100	6	3
Depreciation of Furniture				7	13	8
Removal Expenses				9	7	0
				£1,980	17	2

Income.

	£	s.	d.
Subscriptions Received	1,779	12	0
Sale of Proceedings, etc.	10	11	0
Interest on War Loan and Cash on Deposit	34	8	0
	£1,824	11	0
Excess, Expenditure over Income	156	6	2
	£1,980	17	2

BALANCE SHEET, DECEMBER 31, 1926.

Liabilities.

	£	s.	d.	£	s.	d.
Subscriptions paid in advance				153	12	6
Sundry Creditors				411	16	6
The Oliver Stubbs Medal Fund—						
Balance from Last Account	206	2	0			
Interest to date	8	4	4			
	214	6	4			
Less: Cost of Medal	9	10	0			
				204	16	4
Surplus at December 31, 1925	986	5	6			
Less: Excess of Expenditure over Income for the year ended December 31, 1926	156	6	2			
				829	19	4
				£1,600	4	8

Assets.

	£	s.	d.	£	s.	d.
Cash in Hands of Secretaries—						
Lancashire	24	16	6			
Sheffield	85	8	4			
London	70	15	9			
East Midlands	20	15	6			
West Riding of Yorkshire	28	17	6			
Newcastle	4	2	11			
Wales and Monmouth	0	7	4			
Middlesbrough	20	15	11			
				255	18	9
Lloyds Bank, Limited—						
General Account	237	16	8			
Deposit Account	400	0	0			
				637	16	8
Oliver Stubbs Medal Fund—						
£342 5s. 7d. Local Loan £3 per cent. Stock at cost	200	0	0			
Balance in hands of Lloyds Bank, Limited	4	16	4			
				204	16	4
Investment Account—						
£100 5 per cent. National War Bonds £350 5 per cent. War Loan at cost				432	10	1
Furniture and Fixtures—						
Per last Account	76	16	6			
Less: Depreciation 10 per cent.	7	13	8			
				69	2	10
				£1,600	4	8

We have prepared and audited the above balance sheet with the books and vouchers of the Institute and certify same to be in accordance therewith.

J. & A. W. Sully & Company,
Chartered Accountants,
Auditors.

On the motion of Mr. Oliver Stubbs (Past-President of the Institute), seconded by Mr. W. B. Lake (President-Elect of the London Branch), the annual report of the General Council for the year 1926-27 was adopted.

On the proposition of Mr. J. T. Goodwin (President-Elect of the Institute), seconded by Mr. J. Haigh (Lancashire Branch), the balance sheet and statement of accounts for the year 1926 were approved and adopted.

Amendment of Bye-Laws.

On the motion of Mr. Wesley Lambert (London Branch), seconded by Mr. S. H. Russell (Vice-President), it was resolved that the bye-laws relating to suspension and expulsion of members be amended in accordance with the circular forwarded to members. The object of the amendments was to simplify the working of the Branches and to enable the Branches to make decisions without reference to the General Council.

Diplomas.

It was announced by the General Secretary (Mr. T. Makemson) that the Institute's Diploma had been awarded to the following for Papers read during the past session:—

Mr. J. E. Hurst (Sheffield Branch): "The Influence of Sulphur in Cast Iron."

Mr. A. E. Peace (East Midlands Branch): "A Comparison of Blackheart and Whiteheart Malleable Cast Iron."

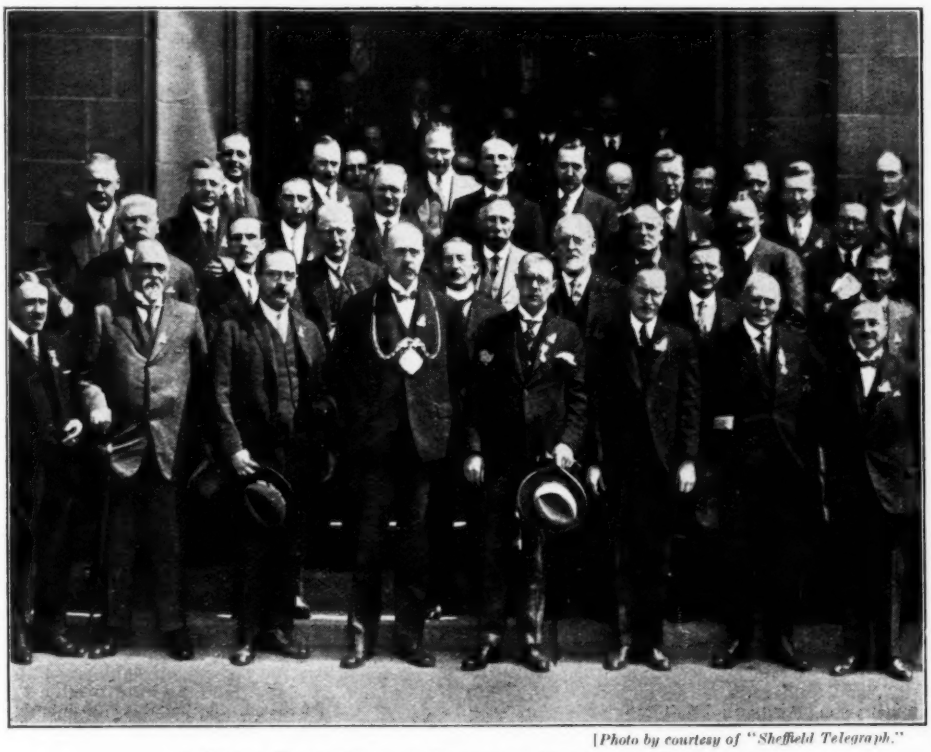
Mr. H. C. Dews (London Branch): "Contraction in Alloy Casting."

Messrs. H. V. Grundy and A. Phillips (Lancashire Branch): "Refractories in the Foundry."

MR. OLIVER STUBBS (Past-President), seconding, said that Mr. Goodwin could have occupied the chair long ago, and it was his own fault that he had not. Mr. Stubbs trusted that Mr. Goodwin, during his year of office, would enjoy good health, and would be supported by the members generally in the manner in which he himself had been supported during his own term of office.

In view of the enthusiasm with which the resolution was received, Mr. Faulkner remarked that it was unnecessary to put it formally to the meeting. He therefore invested Mr. Goodwin with the President's Chain of Office, and the latter formally occupied the chair. The members, standing, gave him a hearty reception.

The PRESIDENT, expressing his appreciation of the honour bestowed upon him, said that he would uphold to the best of his ability the traditions of the Institute and do his utmost to advance its interests. He trusted that throughout his period of office he would carry with him the goodwill of the members, and that at the end of that period—if it were possible—he would have left the Institute in even a more prosperous and more healthy condition than it is at present.



[Photo by courtesy of "Sheffield Telegraph."

A GROUP TAKEN OUTSIDE SHEFFIELD UNIVERSITY BUILDINGS.

Included in the group are Mr. J. T. Goodwin (wearing his chain of office), Mr. Ropsy on his right, Mr. O. Stubbs extreme right. On the president's left are Messrs. V. C. Faulkner, Tom Makemson, F. J. Cook and W. A. Macdonald. In the second row there are Professor Desch, Mr. W. Lambert, and Emeritus Professor Turner.

Mr. J. W. Donaldson (Lancashire Branch): "The Heat Treatment and Growth of Cast Iron."

Mr. W. J. Molineux (Newcastle Branch): "The Manufacture of Iron Castings for Petrol Engines."

Mr. H. Field (Birmingham Branch): "Some Experiences in the Production of Malleable Castings."

Election of Officers.

President.

MR. FAULKNER, proposing that Mr. J. T. Goodwin be elected President for the ensuing year, said that the Institute would have had the greatest difficulty in finding a member who had given more whole-hearted attention to its affairs or who had worked so willingly on its behalf as had Mr. Goodwin. Nothing had been too much trouble to him during his twenty or so years' connection with the Institute. The members appreciated very highly the work he had done in the past, and had every confidence that during the next twelve months the affairs of the Institute could not be in better hands than his.

Presentation of Medal to Past-President.

The PRESIDENT then presented to Mr. Faulkner the Medal which it is now the practice to present to Past-Presidents as a memento of their year of office, in substitution for the Diploma which it was previously the practice to present to them. He was very thankful, indeed, he said, that he had been tutored by Mr. Faulkner, who had been more than a father to him and had taught him many things which a President-Elect ought to know before occupying the chair. In a tribute to Mr. Faulkner for the good work he had done for the Institute, he said it had been done very quietly, but very powerfully. The "Journal" of which the members were so proud, as representing the Institute, had done more in the way of propaganda work in every direction than anything else they could possibly think of, and they all knew that Mr. Faulkner's was the guiding hand at the back of it. He was proud to be able to thank Mr. Faulkner most sincerely, on behalf of the members, for the work he had done.

What had pleased them perhaps more than anything else was the really sincere and sympathetic manner in which he had met everyone; he had gone out of his way to visit all the Branches, and to get to know the wishes of the Institute as a whole. Finally, the President expressed the members' most sincere wish that Mr. Faulkner would enjoy a long and happy life, and the hope that it would be a very long time before he relinquished his support of the Institute.

Mr. Faulkner, responding, said that the past year had been a very happy one, although it had commenced at a time of very great industrial depression, and he took the opportunity to thank his Vice-Presidents, Members of Council, and the general body of members for the wonderful support they had given him. He also expressed thanks to the American Foundrymen's Association for the hospitality they had extended to the important delegation which had visited America last autumn. His thanks were also due to other societies, and he referred particularly to the Belgian Foundrymen's Association, because Britishers had always received a princely welcome from the Association when they had visited Belgium, and there was a very strong bond of sympathy between Mr. Ropsy, the President of the Belgian Association, and the Institute. The French Association, too, had cemented the already good feelings which existed between it and the Institute by inviting the latter to take part in a conference to be held in September in Paris. Again, during the year the Institute's relationship with the German associations had been cemented, and he was pleased to welcome to the Convention, for the first time since the war, representatives of those associations, namely, Dr. Piwowarsky and Herr Nipper, of Aachen. The Institute had been honoured during the year by invitations to participate in the twenty-first birthday celebrations of the Sheffield University, and Mr. Goodwin and himself had represented the Institute on that occasion. Further, he had been received by the National Federation of Iron and Steel Manufacturers, the Iron and Steel Institute, the London Iron and Steel Exchange, the Institute of Metals, and many other bodies, and he felt that the present occasion offered an opportunity for him to express thanks to those bodies for the many kindnesses which the Institute had received at their hands. Finally, he thanked his directors and colleagues for generously according him facilities to attend to the business of the Institute.

Vice-Presidents.

On the motion of Mr. Oliver Stubbs (Past-President), seconded by Mr. F. J. Cook (Past-President), and supported by Mr. H. Pemberton (President of the East Midlands Branch), Mr. S. H. Russell (of Leicester) was unanimously elected Senior Vice-President.

Mr. Russell, returning thanks for his election, said he felt he had received very much more from the Institute than he could ever put into it, and he could only promise that he would do his very best to carry on its work during his period of office. He also expressed thanks on behalf of the East Midlands Branch, because he felt that his election was more an honour to that Branch than to himself.

On the motion of Mr. W. B. Lake (President-Elect of the London Branch), seconded by Mr. H. Winterton (Scottish Branch), Mr. Wesley Lambert (Past-President of the London Branch) was unanimously elected Junior Vice-President.

Mr. Lambert, who also returned thanks, said that he believed it was his own fault to a very large extent that he had not taken office a few years ago, but the circumstances at that time were such that he was unable to accept. The difficulties which had then stood in the way had now been removed, however, and he looked forward to his year of office in the chair in the future with a very great deal of pleasure, because he had been connected with the foundry industry practically all his life, and, though he belonged to quite a number of institutions, the Institute of British Foundrymen was the one nearest and dearest to his heart. He said that largely because there was a great deal of human nature in the Institute. The class of men one met were really good men, and he had found in the industry that the British working man—the craftsman—when one got to know him, was a real good fellow, and one could always get the information one required from him.

Hon. Treasurer.

On the motion of Mr. Faulkner, seconded by Mr. Lambert, Mr. F. W. Finch was re-elected Hon. Treasurer. Mr. Finch, who has been connected with the Institute since its inception, and at one time carried out the duties of Honorary Secretary, had written to express his regret that he was unable to attend the Convention, owing to the illness of Mrs. Finch. On the suggestion of Mr. Stubbs, it was agreed that a letter be sent to Mr. Finch from the Convention, expressing sympathy and good wishes.

Members of Council.

As the result of the ballot to fill the five vacancies on the General Council, the following were re-elected:—Mr. W. T. Evans (Derby); Mr. A. Firth (Sheffield); Mr. J. Haigh (Wakefield); Mr. A. Harley (Coventry), and Mr. H. Winterton (Milngavie, Dumbartonshire).

Trustees.

On the proposition of Mr. A. Firth (Sheffield), seconded by Mr. E. Stevenson (East Midlands Branch), the following were re-elected Trustees of the Institute:—Mr. F. J. Cook, Mr. Oliver Stubbs and Mr. R. O. Patterson.

Re-Election of Auditors.

On the proposition of the President, seconded by Mr. Faulkner, Messrs. J. & A. W. Sully & Company (chartered accountants) were re-elected auditors.

Welcome to Foreign Delegates.

A telegram was received from Mr. H. Cole Estep (Chairman of the Committee of International Relations of the American Foundrymen's Association) conveying the heartiest and best wishes from that Association for a successful conference.

The President then extended a very hearty welcome to delegates from kindred associations abroad. The Institute, he said, had great pleasure in welcoming Mr. Ropsy, the President of the Belgian Foundrymen's Association and President of the International Foundrymen's Committee. They also were greatly honoured by the presence of Professor Dr. Ing. Piwowarsky and Herr H. Nipper, of the Technical High School, Aachen, Germany; Mr. J. A. Penton, of Cleveland, Ohio, Past-President of the American Foundrymen's Association; and Mr. Earnill, a member of the American Foundrymen's Association. The members of the Institute were most gratified to welcome the visitors on this occasion, inasmuch as they had Papers of very great quality and high standing to offer them.

Mr. Ropsy, who addressed the meeting in French, thanked the Institute very sincerely for its kind invitation to representatives of kindred associations abroad, and expressed the hope that all would derive mutual benefit from the Conference.

Mr. Penton, who also responded, said it always gave him a great deal of pleasure to be in England, and especially to be in the company of foundrymen, because he felt so thoroughly at home with them. His visit was a personal and not an official one. He marvelled at the growth of the Institute and of kindred associations in Great Britain; they were doing wonderful work, and he assured them that those in America were greatly interested in it, and followed their proceedings carefully.

(To be continued.)

The Basset Steel Process.—The report of the Société Française des Acièries Basset states that last year a large rotary furnace was set in operation and yielded good results, when the British coal strike caused an interruption in working as from the month of August, and it was only possible to resume working in January, 1927. The output of this furnace has been raised to its probable limit of 110 to 120 tons per 24 hrs., but certain additions to the plant are necessary before operations on a commercial scale can be realised.

On the Effect of Nickel and Chromium on the Strength Properties of Grey Cast Iron.

By Professor E. Piwowarsky, Dr.Eng., Aix-la-Chapelle.

(*Continued from page* 6.)

The Brinell hardness of almost all the alloys is fairly high. It varies between about 200 and 300. Notwithstanding these high hardness figures all the bars were found to be easily machined with ordinary turning tools, and showed no appreciable increase in shearing strength compared with ordinary cast iron. Continuous turnings 3 to 5 m. in length were obtained on machining, and these were maintained even when the feed was increased. Figs. 2 and 3 show the appearance of these turnings. From the transverse strength figures, and in part also from the tensile strength figures of

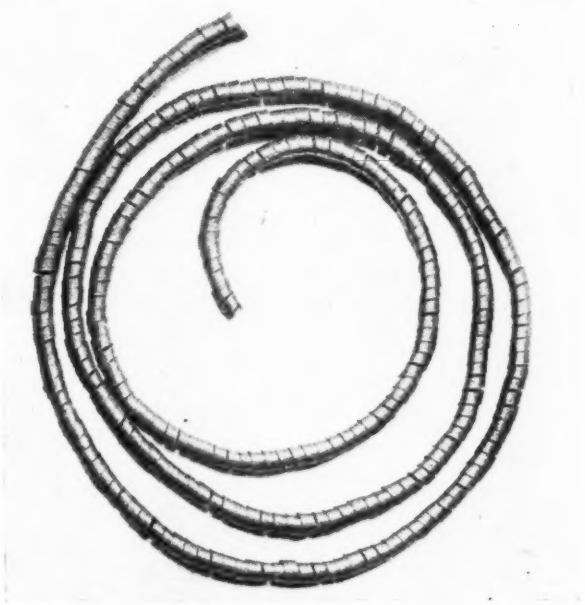


FIG. 2.—APPEARANCE OF TURNINGS SHOWING ELASTICITY—NATURAL SIZE.

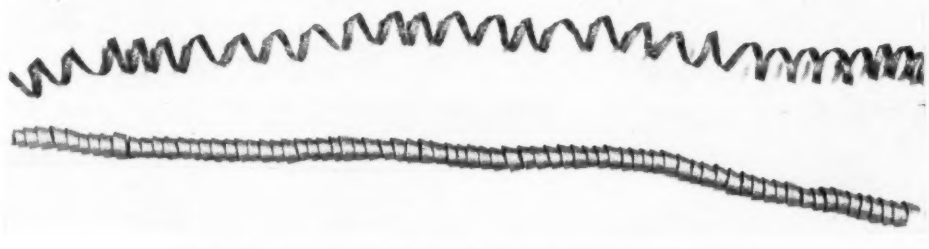


FIG. 3.—APPEARANCE OF THE TURNINGS SHOWING ELASTICITY.

FIG. 4.—BROKEN TRANSVERSE TEST PIECES FROM HEAT BVI × 1.5.

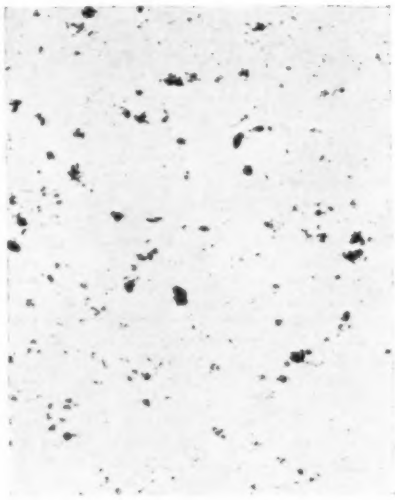


Fig. 5A.—Graphite Structure from Heat A VI × 100.

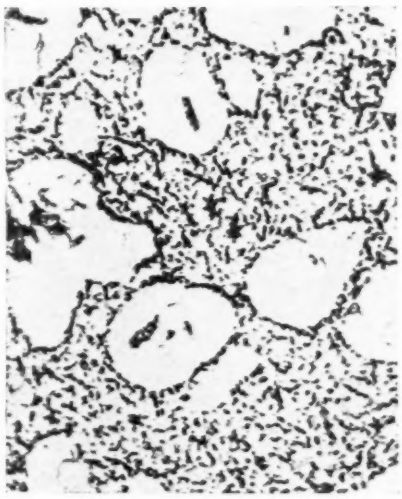
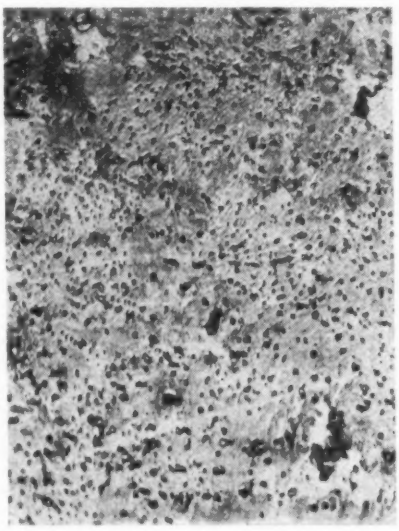
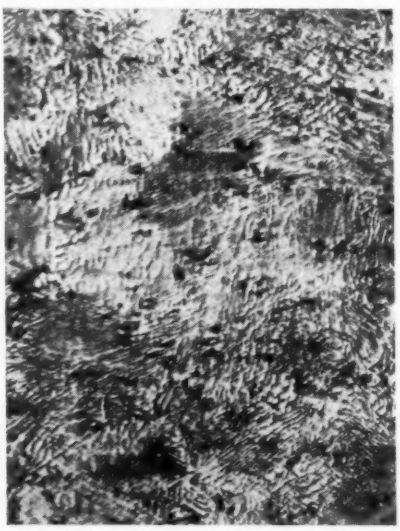


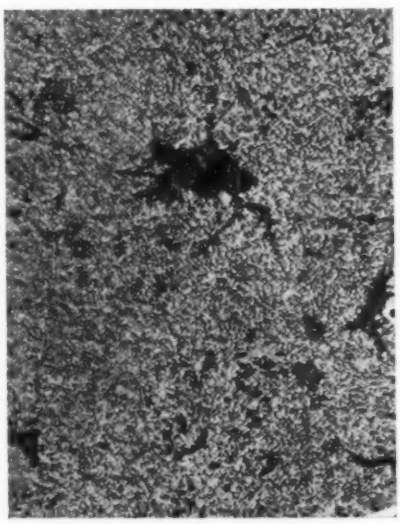
Fig. 5B.—Graphite Structure from B I v × 500.



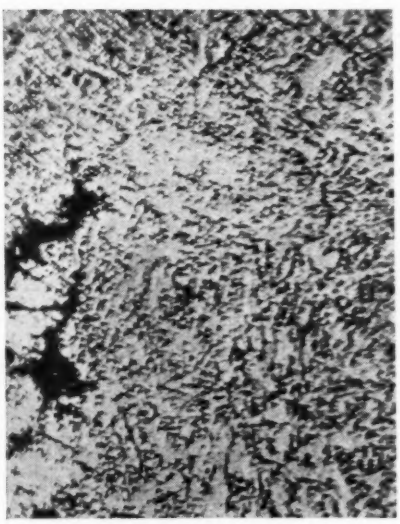
(*a*) × 500.



(*b*) × 500.



(*c*) × 1,000.



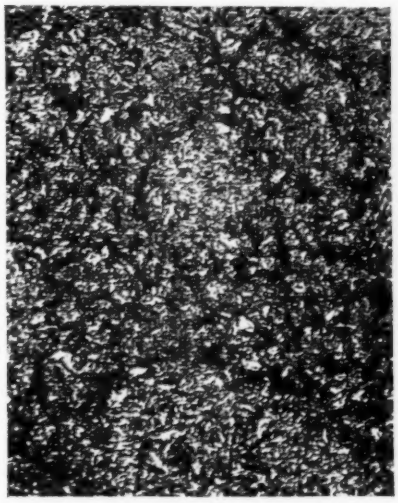
(*d*) × 1,000.

Fig. 6.—Structure of Heat VII, *a* and *b* Before and *c* and *d* After Treatment.

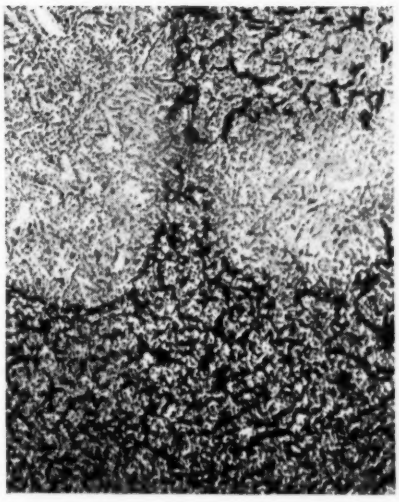
the different samples, it is apparent that a nickel addition clearly exercises a beneficial, although not a very great, effect on the mechanical properties; while on the other hand, nickel in conjunction with chromium is capable of increasing the mechanical properties even of this high-grade iron by 10 to 20 per cent. in the high-carbon series A and by 10 to 30 per cent. in the low-carbon series B. The treated samples, however, indicated in column 2 of Table I by the letter *v*, do not show any noteworthy improvement in the mechanical properties compared with the untreated samples. This is in itself remarkable, but it may material could be distinguished from hardened tool steel only by a practised eye. Fig. 4 shows, by way of example, two fragments which were chipped off in the fracture, which took the form of a cup or basin, of a transverse test bar in heat 12. The fineness of grain resembles, in fact, that seen in the fracture of high-grade tool steel.

At the outset of this Paper it was stated that the thermal after-treatment was so adjusted that a sorbitic-pearlite ground mass with finely-distributed primary carbon must make its appearance. All the micros, in fact, showed in the unetched state a structure of primary carbon in an arrange-

(*a*)



(*b*)



(*c*)

FIG. 7.—STRUCTURE OF HEAT-TREATED CAST IRONS, × 500.

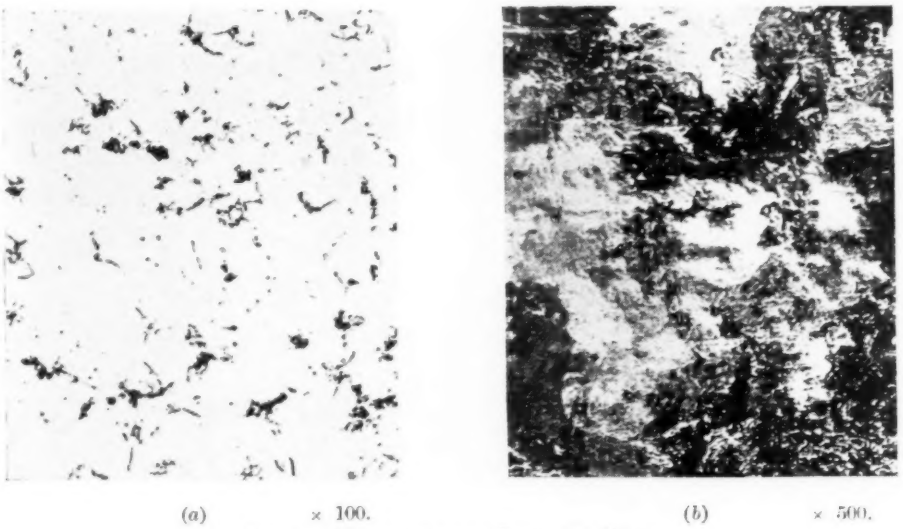
be explained as follows: The grain of the ground mass and the structure of the primary carbon liberated by the annealing process are so fine, owing to the thermal treatment mentioned, that a subsequent alloying process is incapable of rendering the grain still finer. As a matter of fact, in the samples cast in sand an increase of strength of about 10 to 15 per cent was observed as a result of such treatment. Although not large, the increase was certainly present. Among the bars cast in chill moulds, on the other hand, only the melts containing chromium and nickel showed a slight increase in the figures relating to mechanical properties as a result of the adjusting process (*cf.* melts 6 and 12 in Table I).

The structure of the fracture in a large number of the heats—particularly those containing nickel and chromium—was so fine in grain that the ment as regards magnitude such as is shown in Fig. 5a, magnified 100 times. Only a single heat, namely, No. 10, in which through an oversight the carbon content turned out too high, showed even in the final condition, together with considerable quantities of ferrite, very fine-grained eutectic graphite, which could scarcely be distinguished when magnified 100 times. The unetched micro. of this heat had therefore to be reproduced (Fig. 5b) magnified 500 times. Some of the bars showed in parts, together with the primary, as shown in Fig. 5a magnified 100 times, also primary carbon—distributed very uniformly over the sorbitic-pearlite ground mass—of such a high degree of fineness that it had to be magnified 500 times to be identified. This is apparent from Fig. 6 (a and b). These illustrations reproduce the structure of heat 7 magnified 500 and 1,000

times. It will be seen that here also one has to do with a sorbitic-pearlite ground mass, for even when magnified 1,000 times it was still impossible to distinguish certain pearlite fields, which, however, could be done in the case of the heats containing chromium and nickel. The illustrations *c* and *d* of Fig. 6 show the structure of the same heat after the adjusting process, namely, at those points where the coarsest separation of temper carbon was found, so that a comparison of the illustrations *a* and *d* shows the upper and lower limit values in the formation of the elementary carbon in respect of magnitude. It is apparent, moreover, that by the adjusting process the sorbitic-pearlite ground mass has been converted into exceptionally fine granular pearlite of the coagulated cementite. In this connection reference should also be made to Fig. 7, which shows the structure in thermally-regulated sand-cast iron, 7a being that in ordinary grey cast iron, while that in Figs. 7b and 7c is from the samples of sand-cast iron mentioned at the beginning of this Paper, the graphite content of which was caused to solidify in the form of a fine structure by thermal superheating of the melt. It had struck the author that in ordinary, or superheated unalloyed grey cast iron, thermal treatment frequently produces a structure which in its formation resembles blunt needles of martensite, but which in reality has also a preponderatingly granular-pearlitic ground mass, which, however, bears an *apparent* resemblance to martensite—a structural phenomenon which is also observable in the hardening and tempering of steel, and which has led Haneman to establish a new theory of hardening[5] on a metallographic basis.

Whilst it follows from these tests that a nickel addition, particularly in combination with a moderate chromium content, is very well adapted to produce a noteworthy increase in the mechanical properties, even with the best formation of the elementary carbon, it is further apparent, even from the tests so far carried out, that it is possible to obtain by the methods here adopted a special type of malleable cast iron[6] with which strengths hitherto unreached will be associated. Here it is simply a question, in contradistinction to the known malleable-iron process, to cause a metal of which the charge is grey to mottled, to solidify white to mottled by means of artificially-accelerated cooling (pouring in chill moulds or in wet moulds). This type of charge requires, according to the carbon content, silicon contents of about 1.4 to about 2.2 per cent. These small castings, poured white or mottled, can be completely graphitised within a few minutes. The author succeeded, in fact, in completely and uniformly graphitising small castings with a wall thickness up to 35 mm. as quickly as 10 mins. by immersing them in a salt bath at a temperature of 925 to 950 deg. C., when the ground mass showed a sorbitic-pearlite structure with a much finer temper-carbon formation than is observable with the malleablising process as normally practised to-day in America and Europe.

From the results of these researches, moreover, the introduction of a new annealing process, in which quick malleablising would be effected in continuous service with the use of salt baths, would appear to be advantageous. This process was, in fact, practically tested by the author; among other things, insulator bells, which are still made of malleable iron or cast steel, were produced by way of trial in the manner here described in material of excellent quality which was also economical. Fig. 8 shows the structure of an insulator bell of the kind (magnified 100 times), in connection with which it should be expressly noted that the illustration *a* does not by any means represent the finest formation of the elementary carbon. The illustration *b* shows that here also the ground mass is sorbitic pearlite.



(*a*) × 100. (*b*) × 500.

Fig. 8.—Structure of an Insulator Bell.

The phosphorus content of all the heats dealt with was very low. Tests with higher phosphorus contents will be made before completing these researches, and with moderate contents (up to about 0.30 per cent. P) they may even be expected to give still higher strength values, particularly after the addition of nickel and chromium.

Summary.

By causing a cast iron having a grey to mottled charge to solidify at first white to mottled by accelerated cooling, and graphitising it only by subsequent annealing, mechanical strengths of a range hitherto unreached were obtained. In high-grade material of this kind (transverse strengths of 80 to 100 kg./mm². in a perfect bar), a still further increase in the tensile properties of 10 to 30 per cent. (100 to 130 kg./mm².) was effected by the addition of nickel or of nickel and chromium. The deflection of such material in the transverse test is two to three times that of ordinary pearlitic grey cast iron. Tensile tests, in which the elimination of large defects was ensured, showed measurable elongations of 2 to 4 per cent., with values up to 75 kg./mm². (47.6 tons per sq. in.). Notwithstanding the high hardness figures (200 to 300), the machinability of all the samples was at least as good as that of ordinary good grey cast iron.

If suitably turned to account, these tests should result in a quick annealing process giving unusually high strength values with the shortest possible heating period.

[5] Werkstoffausschuss-Bericht des V.D.E. (Report of the Materials Committee of the German Engineers' Association), No. 61.

[6] K. Emmel has already published some figures of the same order of magnitude based upon a similar process (*cf. Stahl und Eisen*, 1925, II, page 1469). P. Bardenheuer also obtained approximately similar figures (*cf. Stahl und Eisen*, 1927, page 857).

The Influence of Manganese and Manganese Sulphide on Whiteheart Malleable.*

By E. R. Taylor, A.R.S.M., D.I.C., F.I.C.

(*Continued from page* 24.)

The Influence of Manganese.

The influence of manganese was then determined using ordinary hematite white iron as employed in the trade. Two series of melts were undertaken, the first having a sulphur content of 0.133, the second of 0.24 per cent., each with increasing manganese. There was ample evidence during higher sulphur melts of the combination between manganese and sulphur, the sulphide rising to the surface in a pasty, viscous mass, fusible with difficulty, and virtually precluding a series being made with sulphur above 0.3 per cent.

In each series the base metal, a hematite pig-iron of 3.09 total carbon, 0.60 silicon, 0.28 manganese, 0.133 sulphur, and 0.103 per cent. phosphorus, was crucible melted with increasing amounts of spiegeleisen to give increasing manganese, high-sulphur pig of similar origin being added in series 2 to give the higher sulphur contents desired. In the first series the manganese

RS 8.

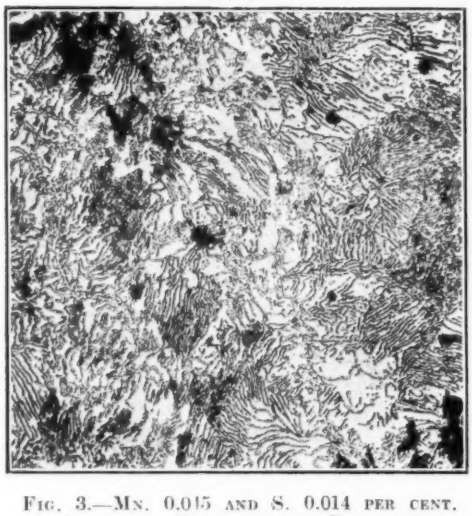


FIG. 3.—MN. 0.015 AND S. 0.014 PER CENT. ANNEALED. ETCHED WITH PICRIC ACID. × 200.

varied in 9 melts from 0.32 to 1.28 per cent. In the second series, in 7 melts the manganese varied from 0.21 to 1.29 per cent., and in both series a little sulphur was lost through manganese sulphide rising to the top of the pot. This loss naturally increased as the manganese increased. In Series 1 the sulphur diminished from 0.133 to 0.10 per cent., and in Series 2 from 0.24 to 0.20 per cent.

For the analyses of the white and annealed bars together with full mechanical tests, the reader is referred to the original Paper.† The bars were annealed in a 1 : 5 ore mixture after barrelling in a commercial gas-fired furnace at A. S. Smith and Sons, Walsall, by courtesy of Mr. G. S. Bayliss. The heating up took 50 hrs., and the cooling 60 hrs., the bars being kept 120 hrs. at 960 deg. C.

In Series 1 the ultimate tensile strength increased with manganese, and the elongation diminished, being 5 per cent. at 0.6 per cent. manganese. All the tensiles were over 20 tons in both Series 1 and 2. In Series 2 the ultimate stress increases with increasing manganese up to 0.6 per cent., and then falls away again. The elongation does the same, increasing up to 0.45 per cent. manganese and then diminishing. The elongation was over 5 per cent. with the manganese between 0.4 and 0.8 per cent., with a peak of 8.5 per cent. at 0.45 per cent. manganese.

Fig. 2 shows the results of the bend tests, indicating the fall of bend value with manganese.

The bend and tensile tests taken together indicate that the best results for a given sulphur

RS 20.

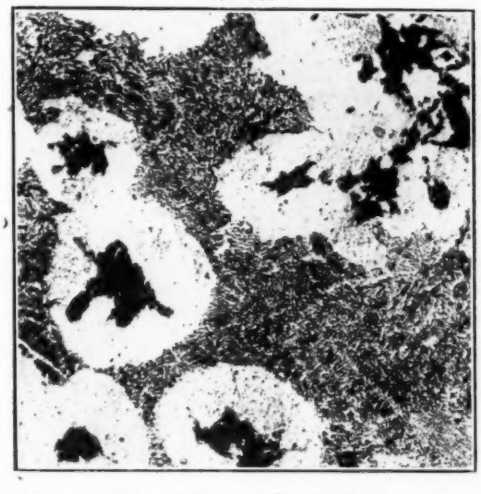


FIG. 4.—MN. 0.17 AND S. 0.131 PER CENT. ANNEALED. ETCHED WITH PICRIC ACID. × 200.

value arise when the manganese is not more than 1 to 2 times the sulphur. In the first series this occurs with the lowest manganese attained, as it was not found possible to go lower than 0.32 per cent. manganese. In the second series the best elongation is given by 0.45 per cent. manganese, the sulphur content being 0.24 per cent.

RS 2.

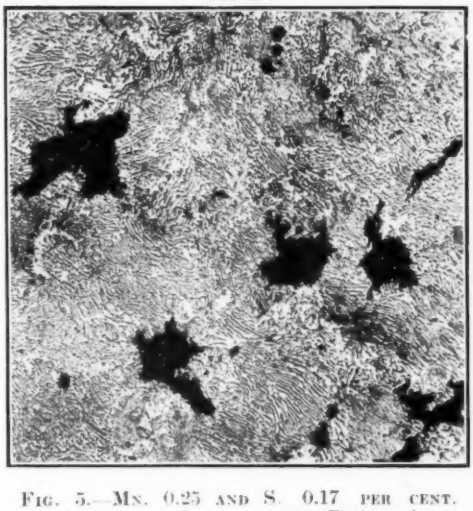


FIG. 5.—MN. 0.25 AND S. 0.17 PER CENT. ANNEALED. ETCHED WITH PICRIC ACID. × 200.

Conclusions.—It may therefore be concluded from these tests that in whiteheart malleable the best mechanical results are obtained when the manganese : sulphur ratio is not greater than 1 : 2. When the ratio is much less than this, good bend tests can be obtained, but the elongation appears to suffer. Metal containing excess manganese is strong without being ductile, and anneals to finely divided pearlite instead of ferrite.

* A Paper presented to the Sheffield Convention of the Institute of British Foundrymen.

† E. R. Taylor, "Carnegie Scholarship Memoirs," 1926, p. 381.

The Influence of Manganese Sulphide.

It was evident from the above-mentioned investigation that better mechanical results were obtained from a low-sulphur pig containing the proper quota of manganese, than from a high-sulphur pig with the proper quota of manganese.

Reference to Fig. 2 not only indicates a deterioration of bend value with increasing manganese, but it will be noted that the bend values for Series 2, containing sulphur 0.24 per cent., are uniformly lower than for Series 1, containing sulphur 0.13 per cent. For a given amount of excess manganese the former iron will contain a larger quantity of manganese sulphide than the latter. Since the mixtures, melting and annealing conditions are identical apart from this one difference, it may fairly be concluded that the ductility suffers if the amount of sulphide present increases. This result was generally supported by other tests irrespective of the character of the base metal, whether blast furnace or refined iron, but it was considered desirable to confirm it with further tests.

These were made on a Swedish iron base of the analysis:—T.C., 3.90; C.C., 3.90; Gr, nil; Si, 0.05; Mn, trace; S, 0.015; and P, 0.015 per cent.

Seven melts were made up of this base with 11 per cent. ferro-silicon, to give a commercial silicon figure of 0.6 per cent., and with calculated amounts of ferrous-sulphide and spiegeleisen to give manganese and sulphur contents varying between the different melts of the series, and yet being fixed in any one melt at the ratio 1.7 : 1. Three standard tensile and three standard bend bars were cast for each melt, being subsequently barrelled, packed in ore in the ratio of 1 part of new to 5 parts of old, and annealed in a commercial, producer-gas-fired oven for 120 hrs. at 960 deg. C. Cooling was slow, being at the rate of 15 deg. C. per hour until 650 deg. C. was reached.

RS 18.

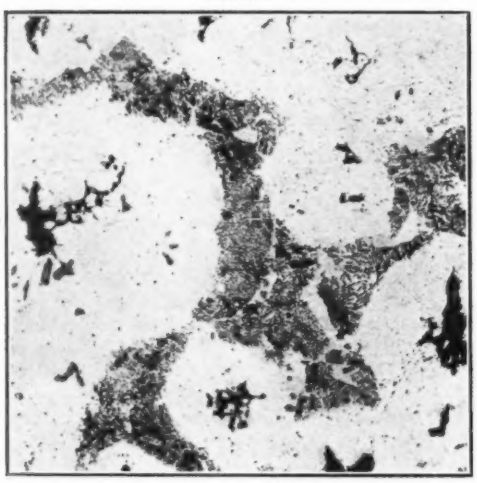


FIG. 6.—MN. 0.386 AND S. 0.187 PER CENT. ANNEALED. ETCHED WITH PICRIC ACID. × 200.

Table I gives the analyses of the white bars, and Table II those of the annealed bars, it being assumed that silicon, manganese and phosphorus remained unchanged during annealing. Table III gives results of mechanical tests, including tensile, elongation and bend tests.

TABLE I.—*White Bars.*

Cast.	T.C. %	C.C. %	G.C. %	Si. %	Mn. %	S. %
RS 8 ..	4.08	4.01	0.07	0.17	0.04	0.014
RS 22 ..	3.54	3.46	0.08	0.55	0.12	0.197
RS 20 ..	3.68	3.58	0.10	0.63	0.17	0.131
RS 2 ..	3.87	3.78	0.09	0.77	0.25	0.170
RS 18 ..	3.53	3.45	0.08	0.79	0.39	0.187
RS 17 ..	3.71	3.61	0.10	0.60	0.33	0.199
RS 9 ..	3.53	3.45	0.08	0.85	0.34	0.213

The phosphorus content remained constant at 0.015 per cent.

TABLE II.—*Annealed Bars.*

Cast.	T.C. Per cent.	C.C. Per cent.	G.C. Per cent.	S. Per cent.
RS 8 ..	1.98	0.65	1.33	0.038
RS 22 ..	1.96	0.74	1.22	0.203
RS 20 ..	1.87	0.66	1.21	0.151
RS 2 ..	2.13	0.83	1.30	0.197
RS 18 ..	1.97	0.52	1.45	0.181
RS 17 ..	2.01	0.66	1.35	0.244
RS 9 ..	1.98	0.69	1.29	0.239

Manganese, silicon and phosphorus contents are assumed to remain unchanged.

TABLE III.

Cast.	Mn. S. assuming all S. changed to Mn. S.	Slight excess of	Ult. Ten. Str. Tons/ sq. in.	Per cent. Elong. on 2 in.	Bend value.
	Per cent.				
RS. 8 ..	0.038	Mn.	23.5	3.6	46°
RS 22 ..	0.193	S.	27.0	4.5	50°
RS 20 ..	0.269	S.	24.6	5.0	40°
RS 2 ..	0.395	S.	25.0	3.7	34°
RS 18 ..	0.509	Mn.	19.6	8.3	90°
RS 17 ..	0.527	S.	20.4	4.0	41°
RS 9 ..	0.542	S.	25.8	5.0	33°

It will be seen from the above results that, in a series in which manganese and sulphur remain related in the same way but in which the actual amounts vary, no definite decline or improvement is shown as the amounts of sulphur and manganese present increase. It is practically difficult to get melts in which the manganese and sulphur are present in a given ratio, even approximately, and the variations in silicon and carbon are quite sufficient to explain the differences shown. The high value obtained for bend in RS 18, in addition to the high elongation, is explained by the high silicon and the low combined carbon after annealing. This iron had annealed wholly to the blackheart condition. It is possible that some favourable condition in mixing or annealing resulted in a greater proportion of sulphur being converted to manganese sulphide in RS 18 than in the other samples, and this would have facilitated annealing to the ferrite-graphite structure capable of yielding relatively good bend and elongation figures.

RS 18.

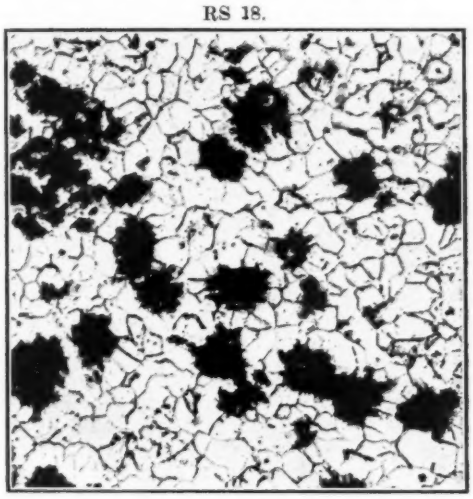


FIG. 7.—ANNEALED BAR (¾ IN.). ETCHED IN PICRIC ACID. MN. 0.386 AND S. 0.187. × 100.

Generally it may be concluded that the presence of sulphide does not seriously affect the ductility of whiteheart malleable, and any harmful tendency is probably more than offset by the acceleration of the annealing due to the combined removal of both sulphur and manganese as sulphide. More reliance should be placed upon the bend tests in the above series than upon tensiles, as ⅝-in. bars were used for the latter instead of

½-in. diameter, and these proved in practice to be unsatisfactory on account of the greater difference in thickness between tensile and bend bars. Five-eighths-inch tensile bars are proposed in the tentative malleable specification, and might well be reduced to the original figure unless a flat bar can be adopted.

Influence of Sulphide on Fracture.

It was noted that in RS 8 and RS 22 the fracture was crystalline and steely, whereas in the other casts the fracture is darker, RS 17 having a black centre with a steely rim ¼ in. thick. RS 18 annealed to a ferrite-graphite structure entirely, with a velvety black appearance. Reference to Table II, however, shows that there is no actual increase in temper carbon deposited as the sulphide increases, except in the one case of RS 18 mentioned above.

RS 22.

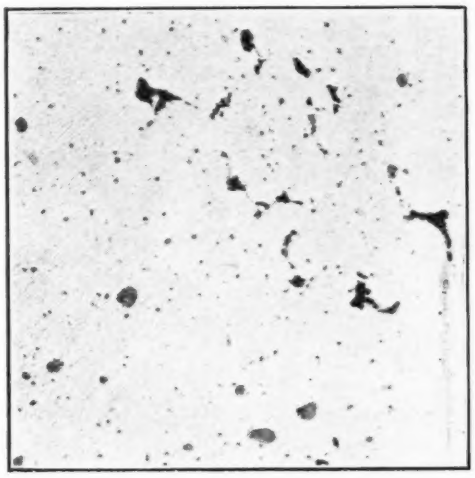


FIG. 8.—MN. 0.122 AND S. 0.197 PER CENT. UNETCHED × 200.

The microstructure of the series in the cast state was normal, except that a little free graphite was present. Fig. 3 shows RS 8 after annealing, being mainly pearlitic. Fig. 4 shows RS 20 after annealing. Fig. 5 shows RS 2 after annealing, and Figs. 6 and 7 show RS 18 of ½ in. bar and ⅜ in. bar respectively, all these being etched.

RS 18

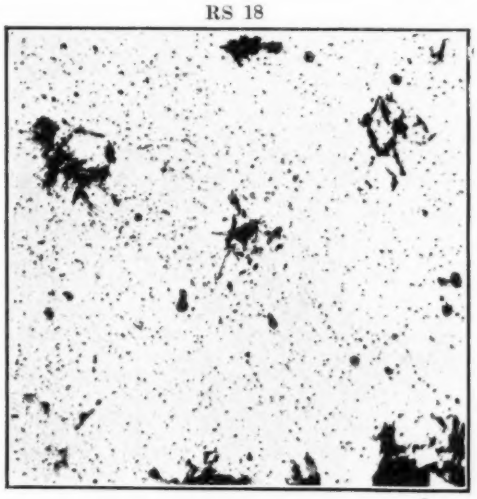


FIG. 9.—SAME SPECIMEN AS FIG. 6, BUT SHOWING HOW THE SULPHIDE HAS SHATTERED DURING ANNEALING. UNETCHED × 200.

Fig. 8 shows RS 22 unetched, showing a small amount of sulphide and temper carbon, and Fig. 9 shows RS 18 with a greater amount of sulphide, and a characteristic effect of the sulphide in very small particles. Fig. 10 shows RS 17 similarly.

Loss or Gain of Sulphur During Annealing.

Sulphur in the white iron castings appears to be affected during the anneal, largely depending on whether manganese is present or not. In the absence of manganese, the sulphur exists as the eutectic Fe – FeS freezing at 980 deg. C., *i.e.*, 200 deg. C. less than the melting point of pure iron sulphide.

In this case the author found elimination of sulphur takes place during the annealing operation to an extent equal to 50 per cent. or more of the original sulphur present.

When manganese is present, however, more particularly over the ratio 1.7 times the sulphur, an absorption of sulphur takes place from the ore mixture, so that there is an increase in sulphur in the annealed castings over that of the white castings.

The following results were obtained as illustrating this:—

TABLE IV.—*Hematite Iron (Manganese absent).*

Original white iron bars. Sulphur per cent.	Annealed bars.	Percentage Sulphur eliminated.
Per cent.	Per cent.	Per cent.
0.151	0.071	53.0
0.25	0.153	38.0
0.324	0.296	8.64
0.65	0.51	21.5
1.28	0.65	49.2

TABLE V.—*Hematite Iron (Manganese present).*

Original white iron bars. Sulphur per cent.	Annealed bars.	Percentage Sulphur gained.
0.133	0.152	14.3
0.121	0.151	24.7
0.115	0.146	27.0
0.117	0.146	24.7
0.109	0.136	24.7
0.112	0.133	18.8
0.11	0.14	27.2
0.24	0.257	7.1
0.213	0.232	8.95
0.211	0.239	13.2
0.20	0.232	16.0

Also in the series in which manganese is present in a definite ratio:—

TABLE VI.—*Hematite Iron, Manganese present in Definite Ratio to Sulphur.*

	Sulphur in the white iron bars.	Sulphur in the annealed bars.	Percentage gain in Sulphur.
	Per cent.	Per cent.	
RS 22 ..	0.197	0.203	3.04
RS 20 ..	0.131	0.151	15.2
RS 2 ..	0.17	0.197	15.8
RS 18 ..	0.187	0.181	— 3.2
RS 17 ..	0.199	0.244	22.6
RS 9 ..	0.213	0.239	12.2

It is difficult to suggest a definite relationship between the manganese content and the behaviour of sulphur during annealing, but the general tendency is clearly indicated.

Conclusions.—(1) Sulphur in the absence of manganese is deleterious to the mechanical properties of whiteheart malleable.

(2) Manganese in the absence of sulphur is deleterious to the ductility of whiteheart malleable.

(3) Manganese and sulphur together neutralise the harmful properties of both, by the formation of sulphide. The manganese may be present in the proportion of 1 to 2 parts manganese to 1 of sulphur, to offset the disadvantage of sulphur without incurring the disadvantage of undue excess manganese.

(4) There seems to be no reason why medium and high sulphur irons, otherwise suitable, should not be employed for whiteheart malleable provided the iron carries the quota of manganese not exceeding that given in (3) above, as the sulphide formed does not appear seriously to affect the mechanical properties. The lowest sulphur pig available, of course, is to be preferred.

(5) Whiteheart malleable bars appear to lose sulphur during annealing when manganese is absent, and gain it when manganese is present, *i.e.*, sulphur change during annealing appears to depend upon the character of the sulphide formed.

The author thinks it desirable to state that the work embodied in this paper was completed before joining the staff of the British Cast Iron Research Association, and has since been continued with respect to the influence of total carbon and silicon on the properties of whiteheart malleable. At the same time the paper could not have been presented

RS 17.

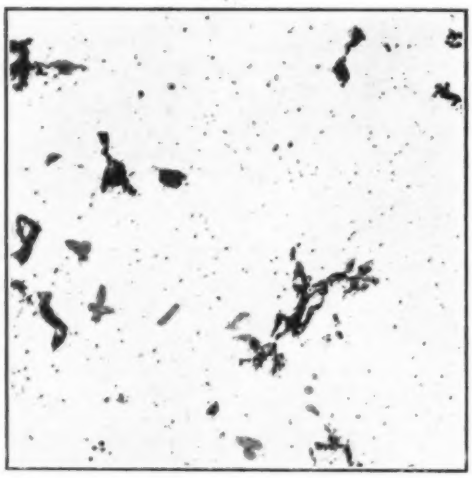


FIG. 10.—MN. 0.333 AND S. 0.199 PER CENT. ANNEALED. UNETCHED × 200.

without the facilities provided by the Association, and to the Director of the Association the author's grateful thanks are therefore tendered, and also to those gentlemen at the works of members of the Association in which the practical annealing work was conducted. The investigations on sulphur and manganese were carried out by means of Carnegie Scholarship grants from the Iron and Steel Institute. The work on the influence of manganese sulphide was undertaken by means of a grant from the Government Grant Committee of the Royal Society.

Company Reports.

Steel Developments, Limited.—Interim dividend, 3 per cent., free of tax.

London Electric Wire & Smiths, Limited.—Interim dividend, 1½ per cent., less tax, on ordinary shares.

Marshall, Sons & Company, Limited.—Payment of preference dividend for half-year ending June postponed.

W. H. Dorman & Company, Limited.—Loss, £7,193; debit brought in, £62,471; debit carry forward, £69,664.

Allen-Liversidge, Limited.—Final dividend on ordinary shares, 5 per cent. (less tax), making 10 per cent. for year.

Workman, Clark & Company, Limited.—Loss for year, £24,510; debit balance brought in, £2,811,912; further reserve to cover taxation, £159,742; total debit balance carried forward, £3,215,457.

Parkinson and W. & B. Cowan, Limited.—Dividend, 7½ per cent., less income tax, on ordinary shares, making 10 per cent. for year; reserve, £17,386; depreciation, £2,019; carried forward, £26,627.

W. & T. Avery, Limited.—Balance of revenue account for year, £137,592; further dividend on ordinary shares, 10 per cent., less tax, making 15 per cent. for year; reserve, £15,000; carried forward, £52,451.

Darlington Forge Company, Limited.—Loss after providing for interest on debenture and sinking fund, but after crediting surplus on taxation, £19,832; debit balance brought in, £190,218; total debit balance, £210,050.

Platt Brothers & Company, Limited.—Net profit, £257,582; debenture interest, £28,857; preference dividend, £79,150; dividend on ordinary capital, 10 per cent., less tax; carry forward, £85,080; brought in, £83,911.

Book Review.

The Working of Aluminium. By Edgar T. Painton. Published by Messrs. Chapman & Hall, 11, Henrietta Street, Covent Garden, London, W.C.2. Price 13s. 6d. net.

It is a real pleasure to handle a book of this character, which does not open up by dealing with the discovery and early development of the metal, its ores and their production. This aspect of the question has been dealt with in books and papers almost *ad nauseum*.

For some curious reason, the author has thought fit to start off with the general properties of aluminium sheet, the better position for which, we feel, would be before the existing Chapter VII—"Sheet-Metal Working." It is, however, an excellent *exposé* of the subject, and, after all, one seldom (except, of course, in the case of students) reads a technical book from cover to cover, but rather does one refer to special sections as and when difficulties arise.

In Chapter II the author has rendered good service to the foundry industry by boiling down to a handy size the non-controversial results published by various workers in the Proceedings of the Institute of Metals. In this way, the alloys of aluminium with zinc, copper and silicon are dealt with.

Chapter III—"Melting and Mixing"—contains perhaps a little too much space devoted to a description of well-known types of furnaces, which information is in a general way obtainable by applying to the manufacturers. This point will be readily appreciated by reference to the informative section dealing with pyrometers, which, if it had been treated similarly to melting furnaces, would surely have contained illustrations of one of the Cambridge Scientific Instrument Company's apparatus. After all, a picture showing a battery of melting furnaces, whilst perhaps being impressive, usually divulges as much information as can be put into half-a-dozen lines of text.

In spite of this criticism, there is much valuable practical information crowded into this section. The practical men amongst our readers will no doubt be interested in Table XII (Chapter IV) which gives the patternmakers' shrinkage figures for a number of the more common alloys. It is interesting to note that apparently the Alpax type of alloy has the lowest shrinkage of the series. The whole of this chapter ("Casting") is thoroughly interesting, and constitutes a valuable practical contribution to the study of the underlying principles for the manufacture of aluminium-alloy castings.

A long chapter is devoted to welding by the oxy-acetylene process, and it is obvious that the author is writing from a full practical knowledge of the subject. Allied matter (other jointing methods) is dealt with in a second chapter, wherein the author rightly stresses the dangers to be associated with soldering.

"Sheet-Metal Working" (Chapter VII) is particularly well illustrated, and it is quite easy to follow from them the methods employed for the fabrication of many familiar articles.

The immediate interest of the founder is again awakened in Chapter IX ("Finishing") by two sections on sand-blasting and tumbling barrel work. The balance, however, in the main refers to wrought work. The book, which is well illustrated and indexed, can be recommended as a thoroughly reliable text book for the ground which it has set out to cover.

Foundrymen Want to Know.

Why the well-known Scotch foundryman has forsaken the reel for Charleston? Was it the influence of All-spice or a wee drappie?

Whether the members of the Lancastrian Society could pronounce the name of the chief guest immediately after the first annual dinner?

If the red and green light system ought to be extended to banquets?

Who owned room No. 132 and where No. 136 is situated?

The nature of the recognition to be given to the Institute's newly-discovered raconteur?

Why a member from Derby should appear so worried?

The Manufacture of a Large Steel Casting.*

By F. A. Melmoth and T. W. Brown.

(*Continued from page* 22.)

Sand Preparation.

The main requirements of a moulding sand for such a casting as the one being considered are:—(1) It must be sufficiently bonded to make a good, firm mould, able to resist the erosive action of the large quantity of steel which necessarily flows over it; (2) it must be sufficiently open, although strong in bond, to permit of the easy egress of gases produced during casting; and (3) it must be of such a composition that it can bear without serious fusion the high temperature of the steel with which it is in contact, bearing in mind the length of time such contact takes place and the weight of liquid steel superimposed upon it.

The normal moulding sand, with a silica base, and bonded by any of the usual materials, does not, in the writers' experience, fill the whole of these requirements satisfactorily. The usual material for such heavy castings is some form of moulding composition. These moulding compositions can be obtained from many of the suppliers of foundry materials, ready mixed for use. In many cases, however, they are made up by the foundries themselves, from mixtures which are the result of many years' investigation and trial. Such mixtures are often very jealously guarded, and it must be accepted that such an attitude is quite comprehensible when the importance of the effect of composition regularity and the correct balancing of its various constituents to meet the above outlined requirements are recognised.

In the manufacture of large castings, the risk of failure involves such a heavy loss that too much care can hardly be taken to ensure a satisfactory moulding composition. Careful selection and examination of each and every one of its component materials is highly necessary. The accidental introduction of some material of easy fusibility, for instance, can be attended by such dire results as to make the after fettling of the casting a commercial impossibility.

The base materials of composition are more or less identical, the variations usually being in the nature of varying quantities. Burnt bricks of good quality—firebrick and silica, probably a proportion of used crucible pots—the requisite amounts of good sand, the whole being carefully milled and mixed, and then bonded with the highest quality fireclay, represent the usual schedule of materials from which steel moulding compositions are made up. The presence of a percentage of crushed coke to assist porosity is also common practice.

The Making of the Mould.

Many points require careful consideration before the moulding itself is commenced. It is assumed that all the necessary details on the character of the pattern have been satisfactorily settled, and that it is supplied ready to go into the sand.

The greater part of the mould for the job under discussion being in the floor, it is necessary to decide on the most suitable position in the foundry. The character of the floor, ease in handling and casting facilities, must all come up for the required degree of consideration. In some foundries pits are actually available permanently in the floor, and for some cases this offers decided advantages.

Where this is not the case, a hole of the required size is taken out, and the pattern, supported on loose brick pillars, is placed into it in the actual position of casting. The pattern is then removed and old sand is rammed into a bed approximately to the shape of the brick supports previously mentioned, but about six inches lower all over.

On this sand bed old firebricks are then placed, covered with a layer of well burnt ashes. This ensures a free passage for the gases formed during casting, through the bottom part of the mould.

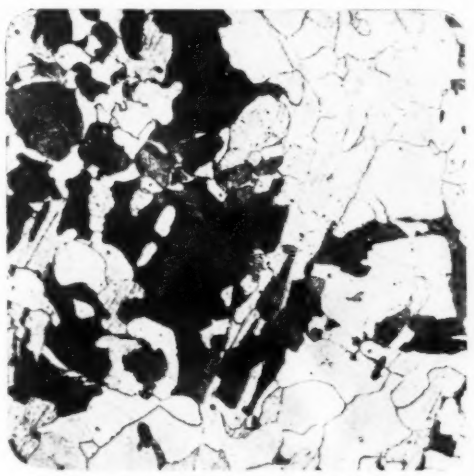


FIG. 8.—STEEL CASTING ANNEALED × 200.

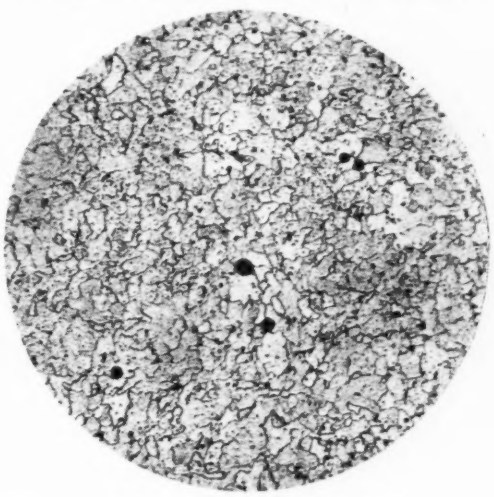


FIG. 9.—WELD METAL × 200.

The ashes are covered by a layer of old sand; the pattern is then replaced allowing about 1½ in. clearance, which is rammed up with the prepared facing composition, previously referred to.

On a job of this character thorough drying is an essential, and during the moulding operations the getting of heat to all parts of the mould must be considered and allowed for. It was, therefore, so arranged as to allow of some parts of the mould being easily lifted out. This served a double purpose, as this particular mould was dried by the building of a fire actually in the mould itself, and not by one of the patent dryers now often used. The lifted-out parts arranged for, therefore, not only permitted of a suitable fire being used, but also opened out the mould so completely as to facilitate its removal and the thorough cleaning of the mould. The lifted away parts were, of course, taken away and suitably stove dried.

A decision being arrived at on this point, the sides and ends of the mould can be proceeded with. Facing composition to a thickness of one and a half inches, backed up by used sand, supported in turn by old firebricks, is rammed up in successive layers. The old bricks are carefully spaced, the spaces being filled with ashes, and suitable vents are led to these, as required. This progresses until the pattern is rammed up to the top, the drawbacks being suitably jointed and built up in the same manner. The joint for the top part is then made and the top rammed up in the usual fashion.

As with all castings, one of the most important points in this one is the position and manner of

* A Paper read before the Sheffield Convention of the Institute of British Foundrymen.

running. A reference to the photograph of this pattern will show that each end is much deeper than the centre portion. Casting from both ends simultaneously, therefore, will mean that the ends will fill first, during which time the steel is rapidly cooling. By the time these two portions are filled and meet one another, the probability is that the advancing edges of the molten steel are so cold as to introduce the possibility of an imperfect union. A weak plane will result, and such a casting being under severe contraction stresses, fracture is not at all improbable.

It was decided, therefore, to cast from one end only. Previous experience had demonstrated that the most satisfactory results were obtained when running was from the boss or larger end. This is in favour of satisfactory casting and feeding.

It will be noticed that the variation in section in this casting is in the form of a progressive reduction from the boss end. To ensure efficient feeding, therefore, one should aim at conditions which produce as nearly as possible a progressive reduction in temperature during solidification from boss end to the end of the palms. By running into the boss such a state of affairs is established; the last and hottest metal, when the casting is full, going into the large riser on the boss. A feeder head of sufficient size satisfactorily to feed this large boss is attached, and the efficient feeding of the boss being ensured the liquid pressure from the heavy end will be found sufficient to make it certain that satisfactory feeding of the rest of the casting takes place during solidification. It is, of course, essential that the riser is the last place to solidify, and it will be seen that in this case this state of affairs is almost ideally present. A reference to the photograph of the unfettled casting (Fig. 3) will still further emphasise this. In the casting shown, the head is approximately 36 ins. above the main level of the casting to ensure a satisfactory pressure and consequent feeding during solidification.

All these points being attended to in the manner stated and the mould and drawbacks being thoroughly dried, the latter are replaced in their respective position, cores inserted and the mould closed in the usual manner (Fig. 2).

In the light of previous experience, any tendency of the top part to lift during casting is counteracted by weighting it down to the necessary extent, and the mould is ready for casting.

After the pouring operation, it is customary in some foundries to attempt to assist contraction by liberating at as many points as possible. The writers are of the opinion that much of this only amounts to wasted effort.

Careful examination of a succession of what are known as contraction "pulls" convinces them that the defect takes place almost at the moment of solidification. Further contraction in the solid form may undoubtedly enlarge or extend such a defect, but it appears rare that a "pull" should take place at a later stage in the cooling period. A crack due to unequal cooling is a possibility, but this is usually due to a desire to hasten matters by stripping the casting too soon. These cracks or "clinks" as they are called, are more likely to occur in the harder types of carbon steels or in alloy steels than in the soft material used for the casting being discussed in this Paper.

Assuming that the writers' opinions are correct, that contraction "pulls" are a defect definitely originating at the moment of solidification, then it logically follows that the correct thing to do is to take such steps during the moulding and core making as will reduce the resistance of the cores and mould to a minimum, and not to rely on the after liberation of the solidified casting for this purpose. Judicious liberation to prevent possible distortion is quite another matter, and a lot can be done in this direction to assist the keeping of the casting in shape.

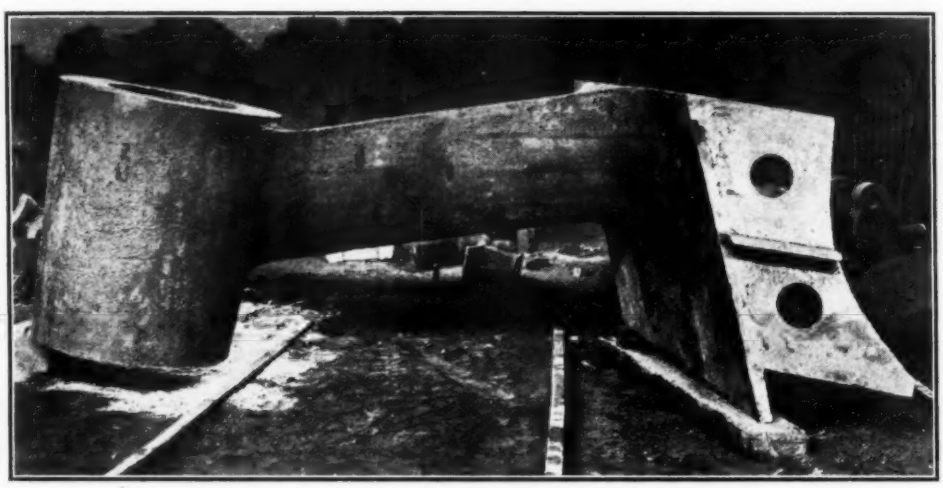


FIG. 10.—FETTLED CASTING.

Annealing.

A sufficient length of time having elapsed to ensure the cooling of the casting to a point at which no danger of fracture exists, it is withdrawn from the mould and moved forward to the annealing operation. Before this operation, it is roughly trimmed and the greater part of the adhering masses of sand removed. Figs. 3 and 4 show the casting in this condition.

The annealing process is designed to perform two very important functions:—(1) By the complete recrystallisation of the steel from a point just above its upper change point, to remove the coarsely crystalline, and therefore weak, structure caused by its cooling from liquid temperatures in the mould; and (2) to remove as far as possible the various strains set up during cooling in the mould, both from the resistance of the mould and from the effects of unequal cooling due to varying section.

The performance of function (1) can be ensured by heating the casting to a temperature of 850 to 900 deg. C., and maintaining it at that temperature for a time sufficient to allow of equilibrium of temperature in all parts of the casting.

At this temperature the crystalline ferrite of the coarse "as cast" type, shown in micro-photograph "5" enters into mutual solid solution with the eutectic pearlite and on cooling is re-crystallised, but with a degree of fineness somewhat proportionate to the temperature to which it has been heated.

Function (2) is one associated with cooling and to remove strains in such a casting it is necessary that it should be cooled both slowly and evenly. Any departure from this may leave the casting almost as badly stressed as before annealing, strains being set up due to unequal speeds of cooling on parts varying in section.

Severe drop tests, to which such castings are subjected, may show up this disastrously. Careful support and packing in the furnace is found to be very necessary for such a job, and in every way steps are taken to ensure that distortion or

sagging is prevented. Should such distortion appear in the casting as it comes from the mould, a great deal can be done by careful manipulation at this point to bring it back into the required shape again.

The influence of correct heat treatment on the physical properties of the material is very marked, and a reference to the table of tests will show that a great improvement is apparent. A comparison of the test figures with the micro-photographs "5" and "7" will make the reason for this improvement at once obvious. It will be seen that as the correct performance of function (1), *i.e.*, the re-crystallisation of the steel involves perfect solution of its ferrite and pearlite constituents, a time factor becomes operative. This is controlled principally by the size of the casting and the thickness of its section.

Violent heating up in the early stages of the annealing process may cause either distortion or fracture, or perhaps both, by the production of sharp variations of temperature between thick and thin sections. It is important, therefore, that the temperature is so controlled that all parts of the casting are heated as evenly as is practically possible. The temperature required being reached, it is then necessary to maintain it for such a period as will ensure the complete solution of the coarse "as cast" crystalline arrangement.

As previously stated, thickness of section is largely the controlling factor, and in such a casting as the one being considered, the soaking period is approximately 12 to 15 hours.

The influence of cooling speed is considerable, but in the case of a large casting, particularly with varying section thicknesses, it is not possible seriously to affect the metallurgical properties by quick cooling, owing to risk of fracture. In the case of smaller or plain castings very marked improvements are noticeable by subjecting the castings after reaching annealing temperatures to a quick cooling, either in air or some suitable liquid medium, with subsequent reheating to a lower temperature to remove any induced stresses.

In the case of the part forming the subject of this paper, however, efforts must be made to ensure, as far as possible, the equal cooling speed of its varying sections, and this can only be done by slow cooling. It is consequently cooled right down at a slow rate in the furnace, and is not exposed to the air until the temperature is so low that all danger of uneven cooling and risk of fracture is well past.

Fully to appreciate the effect and significance of the annealing operation it is necessary to study the physical properties before and after annealing together with the micro-photographs. The micro-photograph shown in Fig. 5 is at 50 dias., and shows the structure as cast. Fig. 6 is the same, but at 200 dias. Micro-photograph Fig. 7 is of the annealed casting at 50 dias., whilst Fig. 8 is the same at 200 dias.

The tensile test results before annealing were: Maximum stress, 29.8 tons per sq. in.; yield point, 15.0 tons per sq. in.; elongation, 14.0 per cent. on 3 in.; and reduction of area, 18.58 per cent. After annealing this became: Maximum stress, 31.2 tons per sq. in.; yield point, 16.6 tons per sq. in.; elongation, 26.5 per cent. on 3 in.; and reduction of area, 31.58 per cent.

The cold bends were respectively 87 and 180 deg. unbroken, before and after annealing.

As a matter of interest, and still further to demonstrate the benefits of the annealing process, impact test pieces were cut from both unannealed and annealed test pieces and broken by the Izod method. The results obtained were: *Unannealed*—18 ft. lbs. (average of two bars); *annealed*—32 ft. lbs. (average of three bars).

It will be seen, therefore, that the summarised effect of annealing on this casting is: (1) It has increased the yield point by approximately 1½ tons per sq. in.; (2) it has raised appreciably the tensile strength of the material; (3) the ductility of the steel, as shown both by elongation and bend test results, has been practically doubled; and (4) the resistance to shock impact of the material, an extremely important feature, has been increased by about 78 per cent.

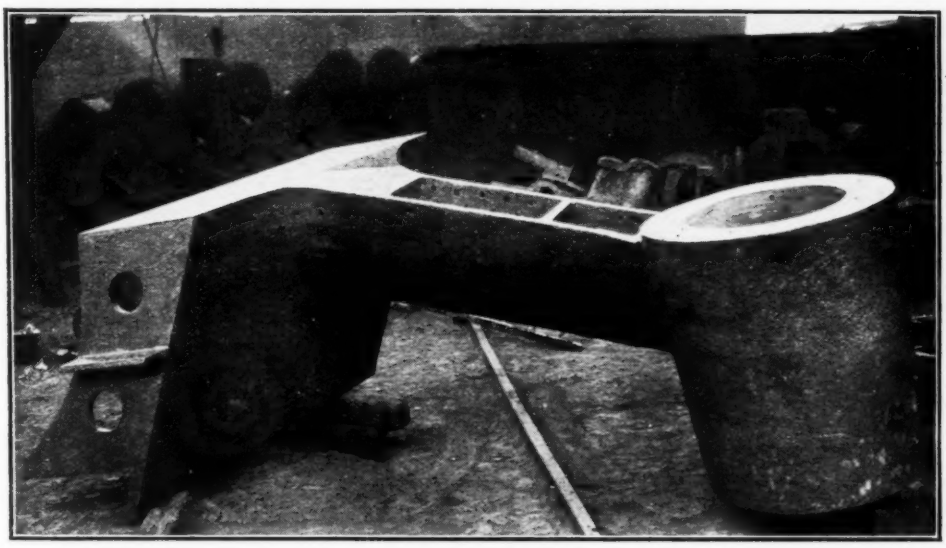


FIG. 11.—FINISHED CASTING.

An examination of the fractures of the broken tests showed, as would be expected, that the as-cast samples were coarsely crystalline, whilst the annealed ones were fine and silky.

A comparison of micro-photographs Figs. 5 and 7 demonstrates that the coarse, strongly latticed and angular arrangement of structure associated with mild steels in their cast condition, has been replaced by a more even and finely-graded structure almost free from pronounced angularity.

Welding.

It sometimes happens that it becomes necessary on such large castings to obtain permission for the welding up of surface defects. The influence of this welding operation, and its value as a means of repairing or improving the external appearance of a casting, has been often discussed, and very often unfavourably. The progress of the art of welding, and the tremendous increase in its possibilities of application, due to this advance, have altered the situation, in the writer's opinion, to a great extent. It is now possible with modern plant to undertake very ambitious structural welding problems, and whilst welding, from a foundry point of view, is never likely to call for such big jobs, the progress along engineering lines does undoubtedly reflect itself on welding operations upon castings. The vast majority of welding cases occurring in a steel foundry are purely matters which affect the appearance of a casting, and there appears no

logical reason why such defects should not, by careful workmanship, be made perfectly good in this manner.

With a view to obtaining some actual data under workshop conditions, the writers have, on occasions, carried out observed tests on welding of cast steel. Bars have been taken representing normal foundry product, and after cutting into two, have been then welded together electrically, the resulting bar being machined and pulled for tensile strength.

They are satisfied that even under shop conditions a well-made weld possesses almost the strength of the original casting, together with a good degree of ductility. Two typical tests are as follows: (1) Maximum stress, 30.0 tons per sq. in. and elongation, 11 per cent. on 2 in.; (2) maximum stress, 29.5 tons per sq. in., and 13.2 per cent. elongation on 2 in.

Whilst admitting that very perfect welds are made by the oxyacetylene process, the writers are of the opinion that for steel foundry purposes electric welding possesses marked advantages. The welds are sound and very quickly produced, whilst the effect on the casting is more local and less likely to produce distortion.

For detailed information of a highly interesting character referring specifically to welding as applied to castings, the writers would refer the reader to a Paper given by Engineer-Commander Jackson before the Sheffield Branch of the I.B.F. on January 24, 1919. In this Paper a number of practical cases are quoted which prove both the value and efficiency of the process even eight or nine years ago. Since that time improvements have continually taken place, both in apparatus and the manufacture of welding rods, and it is safe to say that to-day welding is a most reliable and useful method of repairing steel casting defects, when such defects are of a type justifying repair.

The essential point which should be stressed is that of careful preparation. Absolute cleanliness is vital to the success of the weld, and any attempt to weld an unsound or dirty surface merely results in a deposit of a porous and weak character.

Fig. 9 shows the actual microstructure of the weld metal in one of the test cases previously referred to, and is taken at 200 magnifications.

Inspect and Testing.

Such castings as the one forming the subject of this Paper are almost invariably under the inspection of one or more of the important testing authorities, and the final examination is of a very severe order. They must in all cases be free from external or internal defects likely to weaken the castings in any way, and the material specification must be rigidly adhered to.

The normal physical requirements are as follows: Maximum stress 28 to 35 tons per sq. in.; elongation, 20 per cent. minimum on 2 or 3 in.; and cold bend, 90 deg. minimum on 1 in. sq. bar over 1¼ in. rad.

In addition, a final drop test is applied in which the casting is dropped bodily from the specified height on to a sound floor. Such a test, by applying suddenly severe shock and vibratory stresses, is most likely to show up any hidden points of weakness which may have escaped previous notice.

Having withstood satisfactorily the various material tests and been pronounced free from distortion and visible defects, our casting is then ready for the machine shop. Fig. 10 shows the casting in this condition, and Figs. 11 and 12 illustrate its final appearance, machined and ready for despatch.

The writers, in concluding, desire to record their thanks to the directors of Messrs. Thos. Firth & Sons, Limited, for permission to submit material constituting the Paper, and also to the director of the Brown-Firth Research Laboratories for valuable assistance with the micro-photographs.

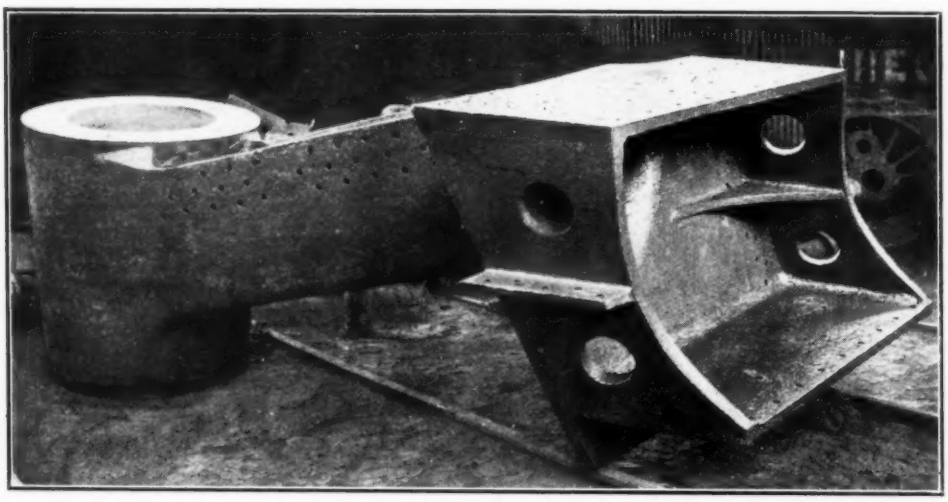


FIG. 12.—FINISHED CASTING FROM THE OPPOSITE SIDE TO FIG. 11.

Company Meetings.

William Cooke & Company, Limited.—The annual meeting was held at the Cutlers' Hall, Sheffield. Moving the adoption of the report, the chairman (MR. H. C. ELSE) referred to the losses that had been caused to the company through the coal stoppage last year. The wire rod trade in this country was suffering mainly because of the enormous amount of wire rods that were coming from the Continent. So serious had the position become that there were more wire rods coming into this country than were being produced by the whole of the rolling mills here. Last year the wire rod trade asked for some relief under the Safeguarding of Industries Act, but the application was not successful. Alluding to the fact that the company had a loss of over £11,000 last year, Mr. Else said he could not see how that loss could possibly have been prevented, owing to the coal stoppage to which he had referred.

Marshall, Sons & Company, Limited.—MAJOR H. D. MARSHALL, presiding at the annual meeting, at Gainsborough, said he was pleased to be able to report a slight improvement in trade. If they had no labour troubles, he hoped there would be a better report to put before them next year. Major Marshall dealt with the adverse balance on the year's working, and emphasised the disastrous effect which the coal strike exercised on engineering firms in their line. When the strike continued, said Major Marshall, the directors were faced with two alternatives, one to practically shut down their works, which would have meant much hardship and distress among the workpeople, or to endeavour to keep the works running, at any rate on part time, in the interests of their employés and shareholders, and in the hope of being able to keep a hold on some of their markets. He felt that, despite the large expenditure this entailed, owing to the enhanced prices of coal and raw material, the shareholders would agree with him that they did the right thing.

The Importance of Air Control in Efficient Cupola Practice.

By P. H. Wilson, M.I.Mech.E. (Stanton Ironworks Company, Limited).

Efficiency and economy are the two essentials in the successful operation of any process. As the cupola is often referred to as the heart of the foundry, it is essential that it should not be considered merely as a shaft into which so much iron and coke is dumped, and air blown through to produce iron in a molten state. This used to be the case years ago, but to-day most foundrymen realise the importance of more scientific control in the process of melting iron.

In the production of any class of casting it is, in the first place, important that the molten iron is of the correct composition and at a suitable temperature for casting. It is false economy to attempt to reduce coke consumption at the expense of a high percentage of waster castings. To produce suitable molten iron economically many factors must be dealt with. These will be treated in their proper sequence.

The real efficiency of a cupola may be measured by the ratio of the heat in the molten metal to the heat generated in the cupola. Thermal balance-sheets have been published in Papers by many writers on this subject during the last few years. The conclusions arrived at from these balance-sheets show that it is chiefly the value of the perceptible and latent heat lost in the gases which decides the thermal efficiency of a cupola furnace. In other words, the cooler the escaping gases and the higher the percentage of carbon dioxide, or conversely, the lower the carbon monoxide in the gases, the greater the heat efficiency of the cupola. Many ideas have been tried to utilise the waste heat passing up the cupola stack, but very little success has been attained in this direction.

Many cupolas operating successfully to-day vary very little in design from those in use fifty years ago. Whilst the results obtained depend on certain principles in the design of a cupola, it is not the writer's intention to deal in this Paper with these details, apart from the construction which directly affects the air supply and distribution of the products of combustion.

The composition of the molten metal is more or less determined by the analysis of the materials charged into the cupola, but inefficient working has a serious effect on certain elements in the iron during the melting operation. Silicon and manganese may be considerably reduced due to excessive oxidation. Further, the absorption of detrimental gases affects the temperature and fluidity of the molten metal; also its physical and mechanical properties.

The efficient working of any cupola depends primarily on the quantity of air supplied at a suitable pressure according to its capacity. The melting capacity of a cupola is determined by its effective diameter at the melting zone. It has been proved that good results are obtained in practice by burning 1 lb. of good coke per hour per sq. in. of cross-sectional area at this point. This is equivalent to from 10 to 12.5 lbs. of iron melted per sq. in. of area per hour. Therefore, a cupola with a diameter of, say, 4 ft. 6 in. is capable of melting economically approximately 10 to 12.5 tons per hour.

By this it will be seen that the figures given for the melting capacity of a cupola relative to its cross-sectional area at the melting zone vary to the extent of 25 per cent. This is dependent on the percentage of coke consumption to iron melted, and also the percentage of carbon in the coke.

The melting rate per hour can be calculated for any sized cupola given the coke consumption per ton of iron and the diameter, as follows:—

M = Melting rate in tons per hour.
D = Diameter of cupola in inches.
P = Percentage of coke to iron (by weight).

$$M = \frac{\pi D^2 \times 1 \times 100}{4 \times P \times 2240} = \frac{D^2 \times 100}{2851\,P} = \frac{0.0351 \times D^2}{P}$$

For example, in a 4 ft. 6 in. dia. cupola with a coke consumption of 8 per cent. the melting capacity would be:—

$$M = \frac{0.0351 \times 54^2}{8} = 12.78 \text{ tons per hour.}$$

If the coke ratio is 1 to 10, or 10 per cent., the melting rate would be 10.2 tons per hour. From the above it will be seen that the higher the coke to iron ratio the greater the melting capacity of the cupola per hour.

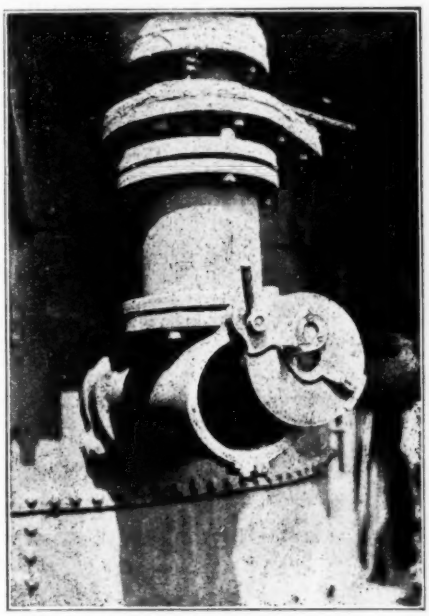


Fig. 1.—Hinged Site Hole for Removing Obstructions.

Having determined the output of the cupola, the amount of air required can be arrived at from the equation:

$$C + O_2 = CO_2$$
$$12 + 32 = 44$$

That is to say, to combust 12 lbs. of carbon completely to CO_2, 32 lbs. of oxygen are required. This is equivalent to 11.6 lbs. of air or 152.4 cub. ft. per lb. of carbon.

As the quality of coke varies, the carbon content must be taken into consideration in calculating the volume of air required per lb. of coke. Further, the volume of air per ton of iron melted will vary with the quantity of coke used per ton of iron.

This can be estimated for different diameters of cupolas for any given coke ratio of a known carbon content, as follows:—

V = Vol. of air per hr. in cub. ft.
v = Vol. of air per ton of iron melted.
D = Dia. of cupola in inches.
P = Percentage of coke to iron charge (by weight).
C = Percentage of carbon in the coke.

$$\therefore V = \frac{\pi D^2 \times 1 \times 152.4 \times C}{4 \quad 100}$$

$$v = \frac{V}{M} = 34.54\,C.P.$$

This gives the theoretical volume of air necessary, but in actual practice allowance must be made for loss through various causes. This amount of loss will depend on the position of the blast-indicating instrument relative to the tuyères. Usually it is placed on the air main leading to the wind belt, and in a position con-

venient to the operator. The actual loss between the blast gauge and the tuyères can be estimated for any cupola according to the general arrangement of the piping, etc.

Having obtained this, the actual volume required at the point at which the blast indicator is fixed can be calculated as follows:—

L = The percentage loss.
V_m = Actual volume of air per min.

$$V_m = \left(\frac{\pi D^2 \times 1 \times 152.4 \times C}{4 \times 60 \times 100}\right) \times \left(1 + \frac{L}{100}\right)$$

$$V_m = 0.01994\, D^2 C \times \left(1 + \frac{L}{100}\right)$$

or five times the diameter at the tuyère level has been found to give good results.

In mechanically-charged cupolas these may be greater to allow a level deposition of the charges below the charging doors. To prove how the "effective height" of a cupola affects the temperature of the rising gases, temperatures of the gases were taken simultaneously at different heights up the stack on two cupolas. The figures obtained were as follows:—

	Cupola A	Cupola B
Effective height	21 ft.	12 ft. 6 in.
Diameter at tuyères ..	4 ft.	4 ft. 6 in.
Ratio (height ÷ diameter)	5.25	2.77

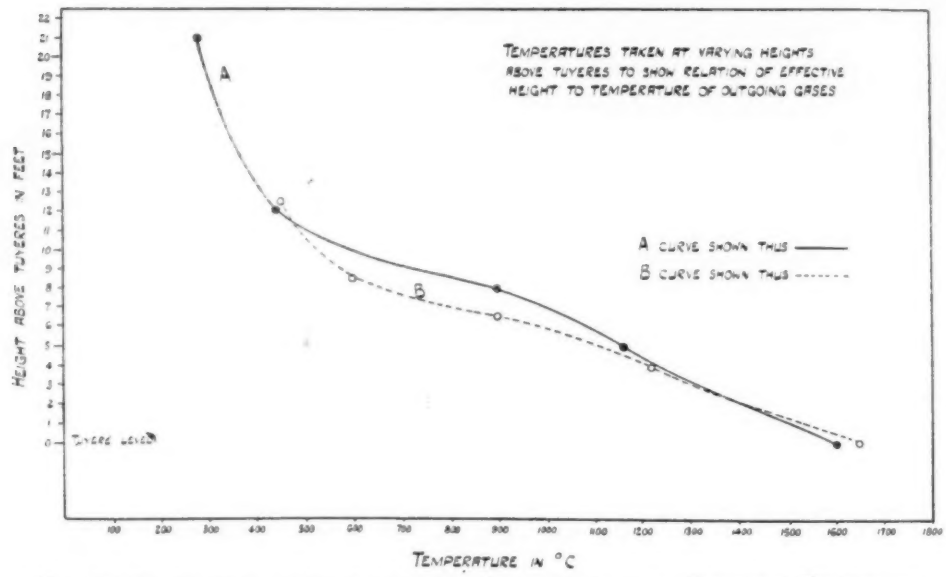

TEMPERATURES TAKEN AT VARYING HEIGHTS ABOVE TUYERES TO SHOW RELATION OF EFFECTIVE HEIGHT TO TEMPERATURE OF OUTGOING GASES
A
B
A CURVE SHOWN THUS
B CURVE SHOWN THUS
HEIGHT ABOVE TUYERES IN FEET
TUYERE LEVEL
TEMPERATURE IN °C

FIG. 2.—TEMPERATURES OF THE GASES TAKEN SIMULTANEOUSLY AT DIFFERENT HEIGHTS ON TWO CUPOLAS.

The method of introducing the air into the furnaces is the next consideration. Various types of tuyères are in use, being circular, square, rectangular and oval shaped, both parallel and flared. In some cases a single row and in others two or more rows are used.

The number and shape of tuyères has long been a debatable point. The main point, however, is that they should be sufficeintly large to admit the correct quantity of air, at a pressure not higher than necessary for the air to penetrate the coke bed and distribute it uniformly at the melting zone.

Having found the pressure necessary, and knowing the volume of air to be passed, allowing for loss in friction, etc., the correct tuyère area can be calculated to give the necessary result for any size of cupola. Therefore, the ratio of the area of the tuyères to that of the cupola will vary according to the area of the cupola.

The 4 ft. 6 in.-cupola under consideration, in which most of the tests reported in this Paper were carried out, has a staggered row of tuyères oval in shape, the area being 18 per cent. of the cupola area, and it has been found that a pressure of 18 in. w.g. is adequate to give a proper distribution of the air.

Another important detail in tuyère design is that each tuyère should be fitted with auxiliary valves, so that when working dirty they can be shut off and burned clear. Poking of tuyères should not be necessary, but it is advisable to provide hinged site holes, through which a bar may be inserted to remove any obstruction. Such an arrangement is shown in Fig. 1.

The effective height of the cupolas (that is, the distance from the top of the tuyères to the charging door) is important. The depth of the well is not so important, this depending on the requirements of the foundry. As the effective height determines the time contact between the hot gases and the burden, the higher this is the more heat is taken from the gases by the descending charge. There is, of course, a limit to the carrying capacity of the coke. A height equivalent to from four

The temperatures obtained in deg. C. were:—

Cupola A.		Cupola B.	
At charging door ..	280	At charging door ..	450
9 ft. below ..	440	2 ft. 6 in. below ..	600
13 ft. ,, ..	900	6 ft. below	900
16 ft. ,, ..	1,160	8 ft. 6 in. below ..	1,220
At tuyères	1,600	At tuyères	1,650

Blast volume per min. (cupola A) .. .. 5,000 cub. ft.
,, ,, ,, (cupola B) .. .. 5,400 cub. ft

Blast pressure w.g. in inches (cupola A) 19
,, ,, ,, ,, (cupola B) 18

It is obvious from the above figures that the effective height of cupola B is too low compared with A, the loss in perceptible heat being high, escaping gases being much cooler in the higher cupola. These results are shown in graphical form in Fig. 2. The temperatures were taken with thermo-couples of various types. For the higher temperatures these were enclosed in nichrome steel sheaths, which melted immediately after the readings had been taken. The temperature at the tuyères was taken with a "Disappearing Filament Pyrometer."

It is interesting to note that the cupola A melted during the one heat 250 tons of metal, and very little variation in temperature was noted during that period. Thompson and Becker point out in their Paper* on "The Chemistry of the Cupola" that when in equilibrium a mixture of CO and CO_2 tends as the temperature falls to change its composition so that a definite amount of each gas is present at a definite temperature. This would tend to cause in the stack a gradual disappearance of CO and its conversion into CO_2.

This is a slight argument in favour of cooling of the gases. Of course, this reaction will be greatly minimised owing to the high velocity of the ascending stream of gases, but may be further aided by reducing the speed of the gas stream—that is, the blast pressure. Also, to assist in this reaction, the area of the stack may be enlarged above the melting zone. This has been found to be effective and to increase the melting rate

* FOUNDRY TRADE JOURNAL, June 24, 1926.

owing to preheating of the descending charge. The more slowly the gases rise, the more complete the heat transference, and the lower the CO in the escaping gases, the cooler the top of the cupola and the better the conditions for charging.

Another important factor in cupola practice is the charging of the materials. Pig-iron, scrap, coke and fluxing material should be properly

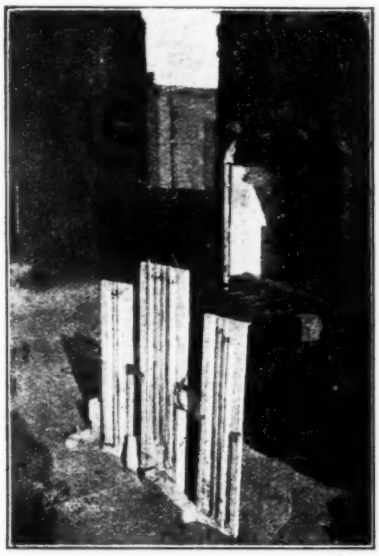


FIG. 3.—DETERMINING THE AMOUNT OF AIR PENETRATING TO DIFFERENT POINTS IN THE AREA AT THE MELTING ZONE.

weighed, and to obtain the necessary result in the resultant metal the iron should be charged according to analysis. The weight and distribution of the charges will vary according to the size of the cupola. It is of vital importance that the layers of materials should be deposited in a level plain.

The weight of iron charge suitable for any size of cupola can be estimated from the weight of the coke layer. The depth of the coke layer should be sufficient to fill completely the cross section of the furnace with a minimum thickness. No accurate figures can be given for this relative to the area of the cupola, as the physical condition of different brands vary, also the carbon content. To obtain the weight of this volume of coke, the common practice is to construct a ring of bricks corresponding with the diameter of the cupola lining, into which the coke is placed.

Limestone, or other fluxing material, should be of uniform size, and charged in proper quantities according to the amount of sand and foreign material adhering to the pig-iron and scrap; 35 lbs. to 50 lbs. of limestone per ton of iron should be sufficient. An excess of limestone increases the coke consumption and causes a greater wear on the lining. A further point is the height of the coke bed above the tuyères. The effect of this on the quality and temperature of molten metal, also the coke consumption, is important in cupola practice.

In many cupola plants known to the writer insufficient attention is paid to the periods of slagging. It is bad practice to hold the slag in the cupola too long, as it tends to blanket the metal from the heat. Cupolas not tapping continuously should be slagged at intervals of not longer than two hours. Further, periodical analyses of the slag should be made to check the iron losses. With iron charges fairly free from rust, the FeO content of the slag should not exceed 3.0 per cent.

Having dealt briefly with some of the conditions which affect the working of a cupola, the points which, in the writer's opinion, are of vital importance will be detailed.

To melt iron, the two principal materials required are fuel (coke) and blast (air). It is in the correct distribution of these two factors that the efficient working of the cupola depends, particularly the air supply. The oxygen in the air is capable of combining with the carbon of the coke to form two oxides of carbon, carbon dioxide CO_2 and carbon monoxide CO. Carbon dioxide is formed where there is excess of oxygen, and carbon monoxide when there is an excess of carbon. The thermal value of these reactions varies greatly. Carbon burning to CO_2 generates 14,500 B.Th.U. per lb. of carbon. Carbon burning to CO generates only 4,500 B.Th.U. per lb. of carbon.

It is obvious, therefore, that the maximum thermal efficiency is obtained when the carbon is burned to CO_2 in one stage. If the carbon is burned to CO, and is further oxidised to CO_2, the thermal efficiency is reduced by approximately 38 per cent. To obtain maximum efficiency the percentage of CO formed must be kept at a minimum. When the air is forced into the layer of incandescent coke above the tuyères, combustion takes place. If the coke layer is uniform in size, shape and disposition, and the air is supplied at

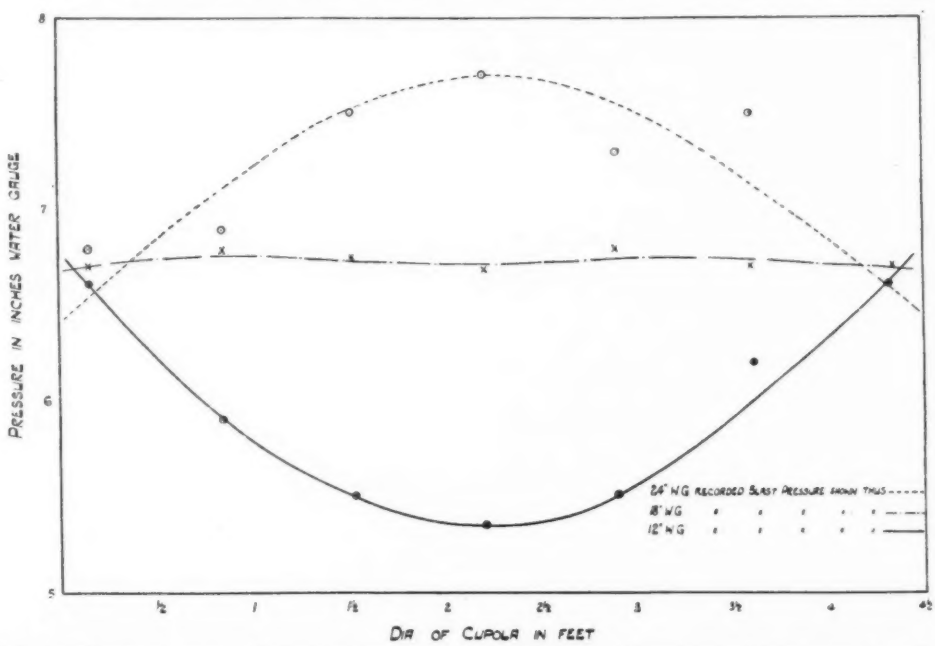


FIG. 4.—DIAGRAM SHOWING PRESSURE OBTAINED AT EACH TUBE IN EXPERIMENT DETERMINING AMOUNT OF AIR PENETRATING TO DIFFERENT POINTS AT THE MELTING ZONE.

the correct velocity and volume, then combustion would be uniform across the coke layer. If these conditions in the cupola are not sufficiently uniform, and the air admitted at too low a pressure, it will not penetrate sufficiently to the centre of the fuel, consequently the combustion does not take place evenly across the section. It tends to be greatest near the lining of the cupola, and the combustion takes the form of an inverted cone.

On the other hand, if the blast pressure is high, then there is a tendency for the combustion to be greater at the centre and the cone to be reversed.

In order to determine the amount of air penetrating to different points in the area at the melting zone, an experiment was made on a 4 ft. 6 in. dia. cupola. Primarily, a series of tubes equally spaced were placed across the cupola, the lower ends of which were perforated and rested on the top of the coke bed, the upper ends being connected to water-pressure gauges. A photograph taken at the time of the experiment is shown in Fig. 3.

The cupola was carefully charged and blown in in the usual way, provision being made to maintain the correct spacing of the tubes during the test. The pressures obtained at each tube indicated the volume of air passing at that point. Arrangements were made to maintain an approximately constant volume of air with varying pressures. In the first place, the air was admitted at a pressure of 12 in. w.g. This was increased to 24 in. w.g. The pressures obtained from each tube were plotted and are shown on diagram, Fig. 4, from which it will be noted that in the former case the curve forms a distinct inverted cone, whereas the curve obtained from the higher pressure is directly opposite.

The depth of the cone formed by the higher pressure is not so intensive as that of the lower pressures. This may account for the trouble experienced with dirty tuyères (referred to previously) when the tuyère area is large compared with the diameter of the cupola, or the velocity of the air is insufficient to penetrate the charges fully, the tendency being for the slag and iron to flow through an outer ring of the melting zone, the pressure of air at the tuyères being insufficient to prevent scaffolding at the tuyères, caused by local chilling. This emphasises the fact that a correct combination of pressure and volume is necessary to obtain an ideal melting condition.

This experiment was repeated, maintaining the same volume at a pressure of 18 in. w.g., which had been found to be the correct working pressure of this particular cupola. The result obtained gave a fairly level distribution of the air across the melting zone.

To check the uniformity of the combustion under what was considered ideal conditions, namely, 5,500 cub. ft. of air per min. at a pressure of 18 in. w.g.—coke ratio 12.3 to 1, gas samples were taken at three levels up the cupola at points 4 ft., 6 ft. 6 in. and 9 ft. 6 in. above the tuyères. These samples were taken from the centre and the sides of the cupola simultaneously, with the following results:—

	Centre of cupola.	Side of cupola.
4 ft. above the tuyère.		
CO_2	18.8%	17.6%
O	nil.	nil.
CO	1.2%	3.2%
6 ft. 6 in. above the tuyère.		
CO_2	18.0%	14.8%
O	nil.	nil.
CO	2.2%	5.2%
9 ft. 6 in. above the tuyère.		
CO_2	17.2%	14.8%
O	nil.	nil.
CO	6.0%	8.8%

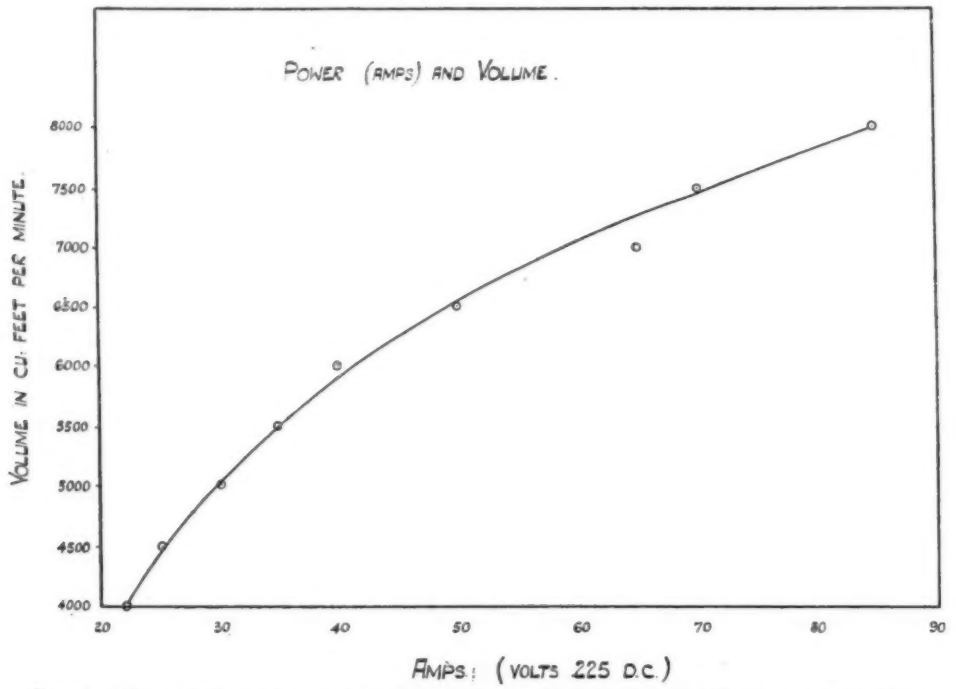


FIG. 5.—TEST SHOWING THAT THE VOLUME OF AIR PASSING INTO THE CUPOLA IS NOT DIRECTLY PROPORTIONAL TO THE POWER ABSORPTION AND THE PRESSURE.

These analyses prove that, under the conditions of correct air volume and pressure, the combustion is fairly uniform across the furnace. All the figures show a high CO_2, absence of oxygen, and the presence of sufficient CO to give a reducing and not an oxidising atmosphere in the cupola.

In addition to proving the above, these figures show that under correct working conditions the method of taking the samples for gas analysis from the side of the cupola gives an approximate indication of the average composition of the gases across the zone.

Further tests were made to find the effect on the resulting gases at different heights using varying coke ratios, the volume and pressure of air remaining constant. These results showed that with a large coke ratio—8 to 1—a high percentage of CO was formed in the gases at a point 4 ft. above the tuyères, and this CO tended to persist up the cupola; with a 10 to 1 ratio there was less CO and more CO_2, showing that the combustion was better, the outgoing gases containing very little CO; and with a 12 to 1 ratio,

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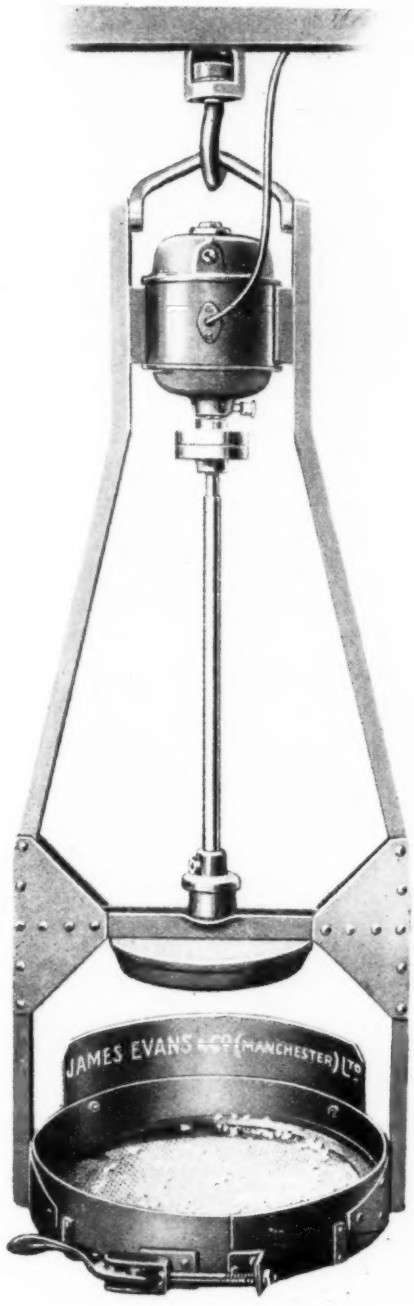

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the CO tends to increase slightly and the CO_2 to decrease.

At each test the analyses were taken simultaneously, and the average results obtained from four tests were as shown in Table I:—

TABLE I.—*Percentage Composition at Varying Heights and Coke Ratios.*

Coke ratio.	8 : 1	10 : 1	12 : 1	Height above tuyères.
CO_2 ..	9.6	14.4	15.2	4 ft. 0 in.
O ..	—	—	0.4	
CO ..	18.0	7.6	8.4	
CO_2 ..	12·0	14.0	17.0	6 ft. 6 in.
O ..	—	0.4	0.2	
CO ..	14.2	9.6	6.2	
CO_2 ..	12.0	18.0	17.6	14 ft. 6 in.
O ..	—	—	—	
CO ..	15.2	4.8	5.2	

It will be seen from the above analyses that with a 12 to 1 ratio there is a slight excess of

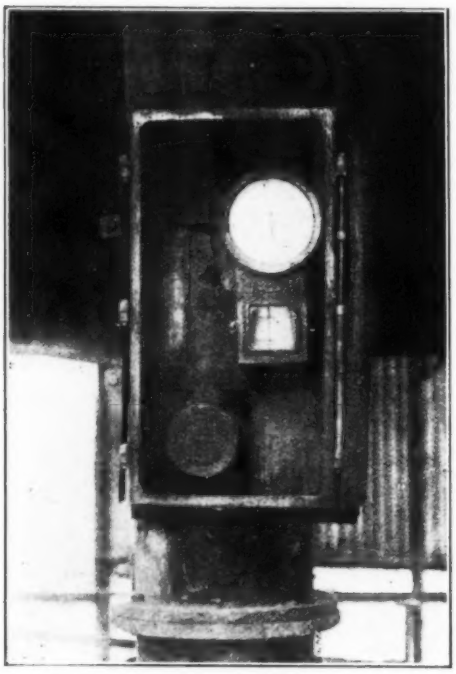

FIG. 6.—INSTRUMENT FOR RECORDING VOLUME AND PRESSURE OF BLAST.

CO in the outgoing gases as compared with the 10 to 1 coke ratio. The loss in latent heat due to this excess CO is more than compensated for by the saving in fuel effected by using the higher ratio. It was found that the temperature of the resultant iron was unaffected by this reduction in coke.

In taking samples of gas for analysis, at a point of, say, 4 ft. above the tuyères, it is obvious that there is a tendency for the CO_2 to vary according to the position of the coke layer above the tuyère.

When the coke charge is just on the melting zone, then the full CO_2 reaction takes place. As the iron charge melts, the next layer of coke descends, the CO_2 reacts with this, and CO is formed, increasing as the coke descends. Then, as this coke reaches just above the melting zone, the full CO_2 reaction recurs.

It is necessary, therefore, to take frequent samples over a period of time required to melt completely one charge. The following analysis illustrates this point, the samples being taken at intervals of two minutes:—

Sample No.	1.	2.	3.	4.
CO_2..	18.8	8.4	14.4	17.5
CO	1.2	18.0	7.6	5.2

Tuyère Ratios.

There seems to be a difference of opinion amongst cupola designers as to the correct ratio of tuyère area to cupola area. A mistaken idea is that large tuyères are difficult to keep clean and free from slag. This is not the case where the correct volume of air is used at a suitable pressure. As stated above, the 4-ft. 6-in. cupola on which most of the tests referred to in this Paper were made has a tuyère area of 18 per cent. To find the effect of different tuyère areas, various sizes were tried by inserting liners into the existing tuyères. The results proved that a reduced tuyère area considerably decreased the thermal efficiency of the cupola, and reduced the melting rate. With a 10 per cent. area the output of the cupola was reduced by 20 per cent.

Further, to maintain the correct volume of air with the smaller tuyères it was necessary to increase the pressure, and although, as stated, the melting rate was reduced, the power consumption on the fan motor increased 40 per cent. The following figures give the results of gas analysis taken during one of these experiments. In Test No. 1 the tuyères were arranged to admit low volume at a high pressure. Test No. 2 was taken under normal working conditions.

Test No.	Pressure. Ins. w.g.	Volume. Cub. ft. per min.	Percentage.	
			CO_2.	CO.
1.. ..	28	3,600	8.2	21.2
2.. ..	18	5,400	16.4	6.0

It has been stated that the volume of air can be regulated, knowing the pressure in the wind belt and the power absorbed by the blower. The writer disagrees with this theory. It is well known that the resistance in a cupola is not constant, therefore it is possible that an increase in pressure may indicate a decrease in volume, or *vice versa*. This applies to both fans and positive blowers. On the one hand, if the resistance is increased, either by choking of the tuyères from slagging or poor quality of coke, or the blast-valve is insufficiently open, the pressure will increase, but the quantity of air delivered will be less, since a higher resistance causes a drop in the fan capacity.

Consider again, towards the end of the blow, when the charge is low, small resistance is offered to the blast, the pressure drops, and a greater flow of air is obtained. If the blast is not properly controlled during the blowing-down period, apart from the oxidising effect on the metal, it is at this period when serious damage is done to the lining. In the case of a positive blower, if the resistance is increased beyond a certain point, the blast is exhausted through a relief valve fitted between the blower and the cupola, which is loaded above the normal working pressure, so that more than the normal power is absorbed and energy wasted.

Tests made with both types of blowers on several cupolas definitely prove that the volume of air passing into the cupola is not directly proportional to the power absorption and the pressure. Several results have been tabulated, and most irregular figures were obtained. One is shown in graphical form in Fig. 5.

As previously mentioned, constant volume of air for a given cupola is essential to good cupola practice, therefore to obtain efficient and economical working conditions, it is necessary that the tenter should have before him a meter showing the volume and pressure of air delivered to the cupola, so that he can regulate his valve accordingly. It is also desirable that this meter should be of the recording type, so that the manager of the plant can check the working of the cupola throughout the heat. Many blast-indicating instruments are actuated on the Pitot tube principle, but many users have found these to be unreliable, due to dust (which is prevalent in most foundries) lodging in the small tubes, which tends to give readings which are misleading. Fig. 6 shows an instrument which simultaneously indicates both volume and pressure. It is also fitted with a recording apparatus, which supplies an accurate chart showing both volume and pressure during the blowing period, also all stoppages.

(To be continued.)

ALUMINIUM ALLOYS
B.E.S.A. Standards

(Part of) Aluminium Data Sheet A 121

Specification. No.	Specified Chemical Composition.[1]	Description.	Minimum Tensile Properties.[3] Ultimate tens. str. Tons sq. in.	Per cent. elongation in 2 in.
3L11	*Copper* 6% to 8% ... *Tin* may be used up to 1%	Casting alloy	9	3
2L8	*Copper* 11% to 13% ...	Casting alloy	9	Nil
2L5	*Zinc* 12.5% to 14.5% *Copper* 2.5% to 3.0% ...	Casting alloy	11	3
L24	*Copper* 3.5% to 4.5% *Nickel* 1.8% to 2.3% *Magnesium* 1.2% to 1.7%	"Y" alloy castings	11	Nil

[1] In each of the above alloys the remainder consists of aluminium and normal impurities.
[2] Tensile tests for casting-alloys are made on specimens machined to .504 in. diameter from samples cast 1 in. diameter in a heated iron chill. Tensile tests for sheet are made on stamped specimens with width ½ in. to 1½ in., and parallel length 2¼ in.

F.T.J. 18/6/27.

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Trade Talk.

THE WIRE ROPE mill at the works of Steel, Peech, and Tozer, Limited, Templeborough, Sheffield, was damaged by an accident to the 54-ton flywheel on June 28.

LAUNCHES ON THE WEAR during June only numbered one vessel, the Brixton, of 1,600 gross tons, launched from the yard of S. P. Austin & Son. For the first half of the year the total output from Wear yards has been eight vessels, aggregating 25,515 gross tons. During the same period last year three vessels of a gross tonnage of 15,780 were launched.

THERE WERE launched all over Scotland during May 45 vessels of 47,391 tons. Of these 28 vessels of 40,465 tons were built on the Clyde, 8 of 953 tons on the Forth, 3 of 5,000 tons on the Tay, and 6 of 973 tons at Aberdeen and Morav Firth ports. The Clyde output of 28 vessels of 40,465 tons during June is the highest this year. For the half-year the total consisted of 100 vessels of only 145,171 tons, as compared with 80 of 156,552 tons last year, 119 of 302,957 tons in 1926, and 127 of 348,476 tons in the best corresponding period—that of 1913.

THE OPERATIONS OF THE Bhadravati Iron Works of Mysore have been showing in recent months marked improvement in every direction. The output anticipated when the Budget was framed last year will be realised in all departments except the pipe foundry, which is a new industry started during the year. The sales show perceptible improvement, and it is expected that there will be equilibrium between the revenue and expenditure for the current year. It is expected that under present conditions the operations during the next year may give a surplus of Rs.3½ lakhs, which will be set apart as the nucleus of a depreciation fund.

THE LIVERPOOL METAL TRADE GOLF COMPETITION, 1927, was held at the West Lancashire Links on June 16, and resulted in three competitors—Mr. Brian Ashcroft, Mr. A. W. Blackwell and Mr. R. R. Turnbull—tieing with 1 down to bogey for the cup (with memento) and the second prize. These gentlemen also divided the sweep. The following won the consolation prizes: Mr. C. V. Anthony, Mr. H. Hughes, Mr. R. R. King, and Mr. H. D. Platten. The putting prize was won by Mr. Lionel S. Taylor. The tie was played off on the same links on June 29, resulting in Mr. Brian Ashcroft winning the cup with memento, and Mr. A. W. Blackwell the second prize.

AN IMPORTANT CONTRACT for super-power station plant for the London Power Company has been placed with the Metropolitan-Vickers Electrical Company. It covers the supply of two 35,000 kw. turbo generator sets which are to be installed at the Deptford West power station, situated on the south bank of the Thames at Stowage Wharf. The work will be carried out to the instructions of Dr. S. L. Pearce, O.B.E., Engineer-in-Chief to the London Power Company, late Electricity Commissioner. The turbines will be two-cylinder machines of 35,000 kw. maximum continuous rating, operating at 1,500 r.p.m., with a steam pressure of 350 lbs. per sq. inch, and total temperature 700 deg. F. They will be arranged with a closed feed-heating and make-up evaporating system. The condensers are to be supplied by Messrs. Richardsons, Westgarth & Company, Limited. The alternators will be single-unit machines at 43,750 kva. capacity, generating at 6,600 volts, 3-phase, fifty periods. With the exception of the 50,000 kva. alternator at present being manufactured by the Metropolitan-Vickers Electrical Company for the Barton power station of the Manchester Corporation, they are the largest single-unit machines yet ordered for installation in Great Britain. They will be arranged for ventilation on the Metropolitan-Vickers' patent closed-circuit system, 70,000 cubic ft. of air per minute being circulated for each machine. The circulation will be effected partly by fans on the rotor and partly by a separate fan. The overall length of each set will be approximately 70 ft. Each complete alternator will weigh 133 tons, of which 52 tons is the weight of the rotor. The total weight of each set, including the condenser, will be nearly 500 tons. A number of sets of this size have already been built by the Metropolitan-Vickers Electrical Company for power stations abroad, including three sets recently completed and now being despatched for the Tsurumi and Amagasaki power stations in Japan. Three sets of even larger capacity are also being manufactured by the same company, one as above mentioned for the Barton power station and two for export.

Central Nickel Information Bureau in Paris.—A Central Information Bureau for Nickel was recently opened at 26, Rue d'Athènes, Paris (9), where French industrialists may obtain free of charge all technical and practical information about nickel. M. Léon Guillet, the well-known savant, is at the head of the Technical Committee assisting the Bureau.

New Companies.

Architects', Engineers' and Surveyors' Defence Union, Limited, 28, Bedford Square, W.C.1.—Limited by guarantee. Directors: W. G. Scott, S. J. Tatchell, G. H. Lovegrove, J. D. Scott and D. B. Niven.

Continental Steel Trading Company, Limited, 64, Victoria Street, Westminster.—Capital £25,000 in £1 shares. Directors: A. J. Matthews and E. A. J. Peach.

R. B. Dunlop & Company, Limited, 372, Scotland Street, Glasgow, S.1.—Capital £3,000 in £1 shares. Engineers. Directors: R. B. Dunlop, W. Mather and A. F. Mackay.

Harris & Ford, Limited, The Protector Foundry, Tipton, Staffs.—Capital £100 in £1 shares. Ironfounders. Directors: H. C. Harvey and A. H. Powis.

Robt. F. Hearn, Limited, 93, Mortimer Street, W.1.—Capital £500 in £1 shares. Engineers. Directors: G. R. Shaw and A. H. Mabley.

Hodgetts Bros. (Birmingham), Limited, 214, Well Street, Hockley, Birmingham.—Capital £1,000 in £1 shares. Brassfounders. Directors: R. Hodgetts and F. Hodgetts.

T. Lewis & Company, Limited, Victoria Brass Works, Salford Street, Burnley.—Capital £5,000 in £1 shares. Brassfounders. Directors: T. Lewis, F. Stansfield and F. Molloy.

Oxhycarbon Company, Limited.—Capital £1,000 in £1 shares. Engineers. Directors: E. C. Weiss, 3/4, Clement's Inn, W.C.2.; and R. Harris, 23, Rectory Grove, Clapham, S.W.4.

Penfold, Limited.—Capital £10,000 in £1 shares (6,000 ordinary and 4,000 10 per cent. preference). Chain link wire fencing manufacturers. Directors: E. B. Bull, 109, Kingsway, W.C.2; and Frances E. Bull, ditto.

Slag Products, Limited.—Capital £7,000 in £1 shares. Directors: M. Odling, "Cherwell," Marton-in-Cleveland, Yorks; R. Burton and C. H. Burton.

Personal.

COLONEL SIR WILLIAM CHARLES WRIGHT, BART. (chairman of Baldwins, Limited) has joined the board of the Union Steel Corporation (of South Africa), Limited.

MR. W. MURRAY MORRISON, who has been associated with the British Aluminium Company, Limited, since its original formation, and who has been general manager for many years, has joined the board of that company. He has also joined the board of the North British Aluminium Company.

MR. E. P. BARFIELD, Managing Director of Automatic and Electric Furnaces, Limited, has sailed for New York to give a series of demonstrations on Wild-Barfield Electric Furnaces (already installed in American works) to a number of engineers and executives of the leading engineering firms in the United States.

SIR ROBERT HADFIELD had conferred upon him at Oxford University on June 30 the honorary degree of D.Sc. This is understood to be the first occasion that the University has awarded the degree to a metallurgist, and Sir Robert regards it as being not so much an honour to himself as a recognition of Sheffield steel. It will be recalled that Sir Robert, in January, 1925, delivered a noteworthy lecture on metallurgy to the students at the Oxford University Junior Scientific Club.

Wills.

HALKET, J. P., of Woodside Park Road, North Finchley, N., for 50 years managing director of the Glengall Iron Works Company, Limited £15,472

GOWER, F. W., of Amesbury Gardens, Moseley, Birmingham, managing director of Birmingham Aluminium Castings Company, Smethwick £18,860

KIND, T. S., of The Groves, Chester, local secretary of Cammell, Laird & Company £15,936

Contracts Open.

Birkenhead, July 18.—(1) Iron, steel, files, bolts and nuts, etc.; (2) cast-iron pipes and special castings; (3) sluice valves and hydrants; (4) brasswork; (5) cast-iron surface boxes; (6) lead piping, sheet lead and block tin, for the six months ending March 31, 1928, for the Town Council. The Water Engineer, 19, Charlesville, Birkenhead.

Sofia, August 1.—220 tons of foundry pig-iron, the estimated value is 880,000 levas (about £1,300), for the Bulgarian Ministry of Railways (Direction Generale de Chemins de Fer, Rue VI Septembre 17, Sofia). The Bulgarian Ministry of Railways, Sofia. (Deposit of 5 per cent. of the amount of the tender.)

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IRON AND STEEL MARKETS.

Pig-iron.

MIDDLESBROUGH.—As far as concerns home demand in the Cleveland iron trade, the general volume of business reported continues below the average, buyers still confining purchases to more immediate requirements, with the fixed idea that a further reduction in prices is only a question of time. However, since the end of the half-year there have been a few more inquiries circulating. In the export section the outlook is distinctly more promising, shipments from Tees ports for the past six months comprising 79,951 tons of pig-iron, against 51,228 tons imported from abroad during that period. Quotations remain unaltered, as follow:—No. 1 Cleveland foundry iron, 72s. 6d. per ton; No. 3 Cleveland G.M.B., 70s.; No. 4 foundry, 69s.; No. 4 forge, 68s. 6d. per ton, f.o.t. or f.o.b.

Tees-side hematite producers raise the same complaint of the absence of any but small orders. Still they manage to keep going, and there has certainly been more inquiry of late. The home demand is quiet, but makers seem to be getting rid of their output and have not found it necessary to cut below previous quotations, viz., mixed numbers 77s. per ton, No. 1 77s. 6d. On the North-West Coast prices are about the same, Bessemer mixed numbers being quoted at £4 7s. 6d. per ton delivered at Glasgow, £4 12s. per ton delivered at Manchester, £4 14s. per ton delivered at Sheffield, and £4 15s. per ton delivered at Birmingham.

LANCASHIRE.—Holiday influences usually experienced at this period have had a quietening effect upon local demands for foundry pig, and markets generally are dull. Apart from Scotch foundry iron, which has eased to round 95s. per ton, delivered Manchester district, quotations have not changed much, Derbyshire being offered at 77s. 9d., Staffordshire at about 77s. 6d., and Middlesbrough at 83s.

THE MIDLANDS.—The market outlook at Birmingham is distinctly improved, and the amount of buying now reported is an advance on the position obtaining a few weeks back. A few consumers are buying for forward delivery at present prices, current quotations ruling about as follow:—Northants No. 3, 62s. 6d. to 65s.; Derbyshire brands, 70s. at furnaces; and Staffordshire No. 3, at from 68s. up to 70s. per ton.

Finished Iron.

Irregular working continues the rule in the South Staffordshire manufacturing departments, with only a slow demand for most classes of finished material, while competition is very keen for what small orders are being placed. For a good line under £10 10s. will be quoted for crown bars, but for small lots the figure varies from £10 10s. to £10 15s. The second grade is quoted between £9 15s. and £10 delivered Midlands. Marked bars are in fair request at a figure of £13 10s. at makers' works. There has been no change in the values of No. 3 foreign bars. Current quotations are in the region of £5 17s. 6d. delivered Darlaston works.

Steel.

At Sheffield the demand for acid billets is a little better, but the position of basic qualities is unchanged. Continental competition is keen, but the volume of such business in this district is comparatively small. The production of open-hearth steel is being slowed down, stocks being equal to all demands during the next few weeks. The state of the steel trades generally is fairly good, although prices are everywhere severely cut. In the tinplate market the home trade is still very quiet, buyers acting very cautiously. Rates are about 18s. 9d. to 18s. 10½d. for coke primes, and 17s. 6d. to 17s. 9d. for wasters in regular sizes, net cash, f.o.t. at works.

Scrap.

Extreme depression is reported from the majority of markets for scrap metal, with perhaps the single exception of Scotland, where prices, though a shade easier in some instances, are firm on the whole. At Glasgow machinery cast-iron scrap is quoted at 72s. 6d. per ton, and for heavy ordinary to suit foundries 67s. 6d. per ton. Old cast-iron railway chairs are a little easier around 72s. 6d. to 73s. per ton; light cast-iron scrap and firebars are around 57s. 6d. per ton. The above prices are all per ton, delivered f.o.t. consumers' works.

Metals.

Copper.—Conditions in the market for warrant copper remain practically stationary, even the speculative element showing but little interest. In addition, the demand from consumers, compared with past experience, is indifferent. Moderate realisations have consequently resulted in occasional easiness, but usually the metal has returned to its previous level.

Official closing prices of standard copper have been as follow:—

Cash: Thursday, £53 15s. to £53 16s. 3d.; Friday, £53 15s. to £53 16s. 3d.; Monday, £53 13s. 9d. to £53 15s.; Tuesday, £53 13s. 9d. to £53 15s.; Wednesday, £53 13s. 9d. to £53 15s.

Three Months: Thursday, £54 5s. to £54 6s. 3d.; Friday, £54 5s. to £54 6s. 3d.; Monday, £54 5s. to £54 6s. 3d.; Tuesday, £54 5s. to £54 6s. 3d.; Wednesday, £54 5s. to £54 6s. 3d.

Tin.—Fluctuations in standard tin values during the past week have taken a somewhat wider range than of late, rendering it difficult to gauge with accuracy the exact position of the market. The increase shown in the visible supply was nothing like so heavy as was anticipated, and to that extent the market has had a better feeling. It would seem that the efforts made to corner spot metal are meeting with difficulty.

Official closing prices of standard tin have been as under:—

Cash: Thursday, £287 to £287 10s.; Friday, £286 5s. to £286 10s.; Monday, £282 10s. to £283; Tuesday, £282 10s. to £282 15s.; Wednesday, £284 to £284 5s.

Three Months: Thursday, £280 17s. 6d. to £281 2s. 6d.; Friday, £280 10s. to £280 15s.; Monday, £278 10s. to £278 15s.; Tuesday, £278 15s. to £279; Wednesday, £279 15s. to £280.

Spelter.—Weakness continues unabated in ordinary spelter. There is apparently no improvement to be looked for in America, at any rate, according to the reports that reach the city, and the only movement likely to influence the position is a reduction in the output. There are no startling movements in Europe.

The following are the week's prices:—

Ordinary: Thursday, £28; Friday, £27 13s. 9d.; Monday, £27 10s.; Tuesday, £28; Wednesday, £27 15s.

Lead.—The market for soft foreign pig, which a short time back was showing some strength, has again relapsed, and the improvement previously gained on the liquidation of stale bull accounts and a falling-off in the demand from consumers has been lost.

The week's prices are appended:—

Soft foreign (prompt): Thursday, £23 5s.; Friday, £23; Monday, £22 17s. 6d.; Tuesday, £22 18s. 9d.; Wednesday, £22 16s. 3d.

Catalogues Received.

Roller and Ball Bearings.—The very nature of the vast foundry industry calls for all types and sizes of roller and ball bearings, and quite often the problems are complicated by the presence of sand, dirt and noxious gases. Thus as an industry they will appreciate the latest catalogue issued by Messrs. Ransome & Marles Bearing Company, Limited, of Newark-on-Trent, which is a veritable text book on the subject. It contains 80 pages, and is well illustrated and indexed. We understand it is available to our readers on application.

Gas Producers.—For some obscure reason the foundry has not utilised to the maximum producer gas for heating and melting purposes, yet for reliability, ease of control and cheapness, it has no superior. A glance at the latest publication on this subject, issued by the Wellman Smith Owen Engineering Corporation, of Victoria Station House, Victoria Street, London, S.W.1 (Section V, Part XR), demonstrates clearly how the manufacture of producer gas has been mechanicalised and made foolproof. The disagreeable job of poking has been eliminated, the suppression of "hot spots," with consequent loss of gas, is assured, and the complete utilisation of the fuel to be gasified made certain. The catalogue under review maintains the high standard which one invariably associates with the name of Wellman, and contains 16 well-illustrated art pages, which contain much useful data.

Cast-Iron Pipes.—The July stock list for cast-iron pipes issued by the Staveley Coal & Iron Company, Limited, of Chesterfield, is now available.

Sterling

BOXES

FOR EVERY FOUNDRY SERVICE.

ADVANTAGES :

50% lighter than cast iron Boxes.

Guaranteed absolutely rigid.

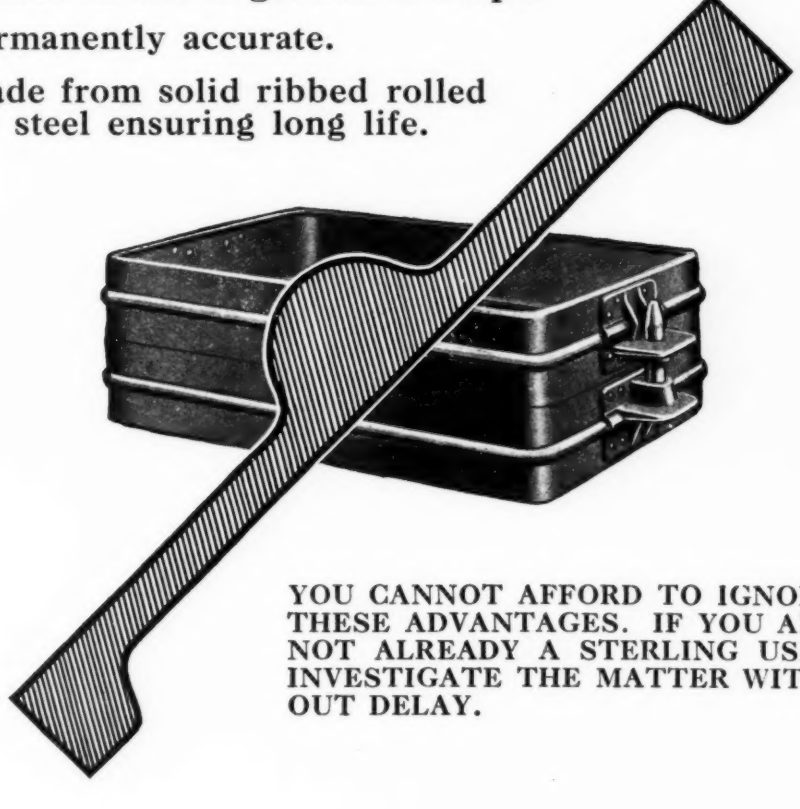
Made to any desired limits of accuracy.

Cannot crack or break.

Cannot distort or get out of shape.

Permanently accurate.

Made from solid ribbed rolled steel ensuring long life.



YOU CANNOT AFFORD TO IGNORE THESE ADVANTAGES. IF YOU ARE NOT ALREADY A STERLING USER INVESTIGATE THE MATTER WITHOUT DELAY.

STERLING FOUNDRY SPECIALTIES LTD.
BEDFORD

London Office: 13, VICTORIA STREET, S.W.1.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	53	13	9
Three months	54	5	0
Electrolytic	59	15	0
Tough	56	10	0
Best selected	57	10	0
Sheets	84	0	0
India	69	5	0
Wire bars	60	5	0
Do. July	60	0	0
Do. August	60	0	0
Ingot bars	60	0	0
H.C. wire rods	64	10	0
Off. av. cash, June 54	1	3 5/16	
Do. 3 mths. June 54	13	9 5/16	
Do., Sttlmnt. June 54	1	2 7/8	
Do., Electro, June 60	1	1 7/8	
Do., B.S., June 58	7	6	
Aver. spot price copper, June 54	1	3 1/2	
Do., wire bars, June 60	4	7 1/2	
Solid drawn tubes		12 1/4d.	
Brazed tubes		12 1/2d.	
Wire		9 1/2d.	

BRASS.

Solid drawn tubes	11 1/4d.
Brazed tubes	13 1/4d.
Rods, drawn	10 3/4d.
Rods, extd. or rlld.	7 1/2d.
Sheets to 10 w.g.	9 1/2d.
Wire	9 3/4d.
Rolled metal	9 1/2d.
Yellow metal rods	7 1/4d.
Do. 4 × 4 Squares	8d.
Do. 4 × 3 Sheets	8 1/2d.

TIN.

	£	s.	d.
Standard cash	284	0	0
Three months	279	15	0
English	281	10	0
Bars	282	0	0
Straits	290	10	0
Australian	290	10	0
Eastern	287	5	0
Banca	292	10	0
Off. av. cash, June 296	2	1 1/8	
Do., 3 mths., June 286	10	10	
Do., Sttlmt. June 296	1	2 3/8	
Aver. spot, June 296	2	1 1/4	

SPELTER.

	£	s.	d.
Ordinary	27	15	0
Remelted	26	0	0
Hard	22	0	0
Electro 99.9	31	5	0
English	28	10	0
India	23	15	0
Zinc dust	37	0	0
Zinc ashes	10	0	0
Off. aver., June	28	12	1 5/16
Aver., spot, June	28	11	11 1/2

LEAD.

	£	s.	d.
Soft foreign ppt.	22	16	3
English	24	5	0
Off. average, June	24	11	10 1/4
Average spot, June	24	8	9

ZINC SHEET, &c.

	£	s.	d.
Zinc sheets, English	37	10	0
Do. V.M. ex whf.	35	0	0
Rods	42	0	0
Boiler plates	34	10	0
Battery plates	34	0	0

ANTIMONY.

	£	s.	d.
Special brands, Eng.	69	0	0
Chinese	52	0	0
Crude	39	0	0

QUICKSILVER.

	£	s.	d.
Quicksilver	21	15	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
25%	£9 0 0
45/50%	£12 7 6
75%	£19 5 0
Ferro-vanadium—	
35/40%	£14/3 lb. va.
Ferro-molybdenum—	
70/75% c. free	5/- lb.
Ferro-titanium—	
23/25% carbonless	11 1/4d.
Ferro-phosphorus, 20/25%	£17 15 0
Ferro-tungsten—	
80/85%, c. fr.	1/5 lb.
Tungsten metal powder—	
98/99%	1/8 1/2 lb.
Ferro-chrome	
2/4% car.	£33 15 0
4/6% car.	£23 15 0
6/8% car.	£23 0 0
8/10% car.	£22 12 6
Ferro-chrome—	
Max. 2% car.	£36 10 0
Max. 1% car.	£42 5 0
Max. 0.70% car.	£54 0 0
70%, carbonless	1/5 lb.
Nickel—99%, cubes or pellets	£170
Ferro-cobalt	9/3 lb.
Aluminium 98/99%	£105
Metallic Chromium—	
96/98%	3/3 lb.
Ferro-manganese (net)—	
76/80%, loose	£12 0 0
76/80%, packed	£13 0 0
76/80%, export	£11 15 0
Metallic manganese—	
94/96%, carbonless	1/10 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

	s.	d.
Finished bars, 14% tungsten	2	6
Finished bars, 18% tungsten	3	0

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares 3 in. and over	4d. lb.
Rounds and squares under 1/4 in. to 1/2 in.	3d. lb.
Do., under 1/2 in. to 1/16 in.	1/- lb.
Flats, 1/4 in. × 1/4 in. to under 1 in. × 1/4 in.	3d. lb.
Do. under 1/4 in. × 1/4 in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.
Bars cut to length	10% extra.
Scrap from high-speed tool steel—	
Scrap pieces	3d.
Turnings and swarf	1d.

Per lb. net, d/d steel makers' works.

SCRAP.

	£	s.	d.	£	s.	d.
South Wales—						
Hvy. steel	3	2	6			
Bundled steel & shrngs.	2	15	0	to 2	17	0
Mixed iron & steel	2	15	0	to 2	17	6
Heavy cast iron	3	2	6	to 3	5	0
Good machinery for foundries	3	5	0	to 3	7	6
Cleveland—						
Heavy steel	2	17	6			
Steel turnings	2	2	6			
Cast iron borings	2	1	0			
Heavy forge	3	15	0			
Bushelled scrap	3	5	0			
Cast-iron scrap	3	2	6	to 3	7	6
Lancashire—						
Cast-iron scrap	3	7	6	to 3	10	0
Hvy. wrought	3	2	6			
Steel turnings	2	0	0			
London — Merchants' buying prices delivered yard.						
Copper (clean)	48	0	0			
Brass (clean)	39	0	0			
Lead (less usual draft)	21	0	0			
Tea lead	17	0	0			
Zinc	19	0	0			
New aluminium cuttings	82	0	0			
Braziery copper	45	0	0			
Gunmetal	47	0	0			
Hollow pewter	180	0	0			
Shaped black pewter	140	0	0			

PIG-IRON

(f.o.t. unless otherwise stated).

N.E. Coast—	
Foundry No. 1	72/6
Foundry No. 3	70/-
Foundry No. 4	69/-
Forge No. 4	68/6
Hematite No. 1	77/6
Hematite M/Nos.	77/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	87/6
,, d/d Birm.	95/-
Midlands—	
Staffs. common*	—
,, No. 4 forge	—
,, No. 3 fdry.	68/- to 70/-
Shrops. basic	—
,, Cold blast, ord.*	—
,, ,, roll iron*	—
* d/d Birmingham.	
Northants forge	—
,, fdry. No. 3	62/6 to 65/-
Derbyshire forge	—
,, fdry. No. 3	69/- to 70/-
,, basic	—
Scotland—	
Foundry No. 1	—
,, No. 3	78/-
Hem. M/Nos.	81/-
Sheffield (d/d district)—	
Derby forge	72/6
,, fdry. No. 3	74/6
Lincs. forge	—
,, fdry. No. 3	77/6
E.C. hematite	89/6
W.C. hematite	94/-
Lincs. (at furnaces)—	
Forge No. 4	—
Foundry No. 3	—
Basic	—
Lancashire (d/d eq. Man.)—	
Derby forge	—
,, fdry. No. 3	77/9
Northants foundry No. 3	—
Dalzell, No. 3	105/- to 110/-
Summerlee, No. 3	95/- to 102/-
Glengarnock, No. 3	95/- to 102/-
Gartsherrie, No. 3	95/- to 102/-
Monkland, No. 3	95/- to 102/-
Coltness, No. 3	95/- to 102/-
Shotts, No. 3	95/- to 102/-

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.	£	s.	d.
Bars (cr.) nom.	10	10	0	to 11	0	0
Angles				—		
Tees to 3 united ins.				—		
Nut and bolt iron				—		
Hoops	14	10	0			
Marked bars (Staffs.) f.o.t.	13	10	0			
Gas strip	12	10	0			
Bolts and nuts 3/4 in. × 4 in.	15	5	0			
Steel—						
Ship plates	8	2	6	to 8	7	6
Boiler plts.	11	0	0			
Chequer plts.	10	5	0			
Angles	7	12	6			
Tees	8	12	6			
Joists	7	12	6			
Rounds and squares 3 in. to 5 1/2 ins.	7	15	0			
Rounds under 3 in. to 1/4 in. (Untested)	8	0	0	and upwards		
Flats, over 5 in. wide and up	9	2	6			
Flats, 5in. to 1 1/2 in.	8	2	6			
Rails, heavy	8	2	6			
Fishplates	12	10	0			
Hoops (Staffs.)	10	10	0			
Black sheets, 24g.	10	17	6			
Galv. cor. shts, 24g.	14	5	0			
Galv. fencing wire 8g. plain	12	10	0			
Billets, soft	6	10	0	to 7	0	0
Billets, hard				—		
Sheet bars	6	5	0			
Tin bars d/d	6	5	0			

PHOSPHOR BRONZE.

	Per lb.	basis.
Strip	1	2 1/4
Sheet to 10 w.g.	1	2 3/4
Wire	1	3 1/4
Rods	1	2 3/4
Tubes	1	8
Castings	1	2

Delivery 3 cwt. free.

10% phos. cop. £40 above B.S.

15% phos. cop. £50 above B.S.

Phosphor tin (5%) £30 above price of English ingots.

C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	per lb.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3 1/2 to 1/9 1/2
To 15 in. wide	1/3 1/2 to 1/9 1/2
To 18 in. wide	1/4 to 1/10
To 21 in. wide	1/4 1/2 to 1/10 1/2
To 25 in. wide	1/5 to 1/11
Ingots for spoons and forks	9d. to 1/5 1/2
Ingots rolled to spoon size	1/- to 1/8 1/2
Wire round—	
3/0 to 10 G.	1/6 1/2 to 2/1 1/2

with extras according to gauge.

AMERICAN IRON & STEEL

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	21.26
No. 2 foundry, Valley	18.00
No. 2 foundry, Birm.	18.00
Basic	20.75
Bessemer	20.26
Malleable	19.76
Grey forge	19.26
Ferro-mang. 80% d/d	90.00
Bess. rails, h'y, at mill	43.00
O.-h. rails, h'y at mill	43.00
Bess billets	33.00
O.-h. billets	33.00
O.-h. sheet bars	33.50
Wire rods	42.00
	Cents.
Iron bars, Phila.	2.12
Steel bars	1.80
Tank plates	1.80
Beams, etc.	1.80
Skelp, grooved steel	1.80
Skelp, sheared steel	1.80
Steel hoops	2.30
Sheets, black, No. 24	3.00
Sheets, galv., No. 24	3.85
Sheets, blue an'l'd, 9 & 10	2.25
Wire nails	2.50
Plain wire	2.40
Barbed wire, galv.	3.20
Tinplate, 100 lb. box	$5.50

COKE (at ovens).

Welsh foundry	—
,, furnace	—
Durham & North.	
,, foundry	—
,, furnace	15/6
Other Districts, foundry	—
,, ,, furnace (basis)	12/6

TINPLATES,

f.o.b. Bristol Channel ports.

I.C. Cokes,	20 × 14, box	18/10 1/2
,,	28 × 20, ,,	37/9
,,	20 × 10, ,,	—
,,	18 3/4 × 14, ,,	—
C.W.	20 × 14, ,,	17/7 1/2
,,	28 × 20, ,,	—
,,	20 × 10, ,,	—
,,	18 3/4 × 14, ,,	—

Terneplates 28 × 20, — per box basis f.o.b.

SWEDISH IRON.

Bars, hammered	£18/10 to £19/0
Rolled Ord.	£15/5/0 to £15/15
Nail rods	£15 12 6 to £16 0 0
Keg. steel nom.	£33 to £35
Faggot steel nom.	£22 to £25
Blooms, according to quality	£8 to £12
Pig-iron all f.o.b. Gothenburg.	£6 0 0 to £6 10 0

TUBES AND FITTINGS.

Up to and incl. 6 in.

	Tubes.	*Fittings*
Gas	67½%	45%
Water	62½%	40%
Steam	57½%	35%

W.I. 10% extra.

DAILY FLUCTUATIONS.

Standard Copper (Cash).

	£	s.	d.	
July 7	53	15	0	inc. 3/9
,, 8	53	15	0	No change
,, 11	53	13	9	dec. 1/3
,, 12	53	13	9	No change
,, 13	53	13	9	,, ,,

Electrolytic Copper.

	£	s.	d.	
July 7	59	15	0	inc. 2/6
,, 8	59	15	0	No change
,, 11	59	15	0	,, ,,
,, 12	59	15	0	,, ,,
,, 13	59	15	0	,, ,,

Standard Tin (Cash).

	£	s.	d.	
July 7	287	0	0	dec. 90/–
,, 8	286	5	0	,, 15/–
,, 11	282	10	0	,, 75/–
,, 12	282	10	0	No change
,, 13	284	0	0	inc. 30/–

Tin (English ingots).

	£	s.	d.	
July 7	284	10	0	dec. 80/–
,, 8	284	0	0	,, 10/–
,, 11	280	0	0	,, 80/–
,, 12	280	0	0	No change
,, 13	281	10	0	inc. 30/–

Zinc Sheets (English).

	£	s.	d.	
July 7	37	10	0	No change
,, 8	37	10	0	,, ,,
,, 11	37	10	0	,, ,,
,, 12	37	10	0	,, ,,
,, 13	37	10	0	,, ,,

Spelter (ordinary).

	£	s.	d.	
July 7	28	0	0	inc. 3/9
,, 8	27	13	9	dec. 6/3
,, 11	27	10	0	,, 3/9
,, 12	28	0	0	inc. 10/–
,, 13	27	15	0	dec. 5/–

Lead (English).

	£	s.	d.	
July 7	24	10	0	No change
,, 8	24	5	0	dec. 5/–
,, 11	24	5	0	No change
,, 12	24	5	0	,, ,,
,, 13	24	5	0	,, ,,

AVERAGE MONTHLY PRICES OF STEEL SHIP PLATES (NORTH OF ENGLAND).

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1896	5 0 0	5 0 0	5 2 6	5 2 6	5 2 6	5 0 0	5 0 0	5 0 0	5 0 0	5 2 6	5 10 0	5 10 0	5 2 6
1897	5 10 0	5 10 0	5 10 0	5 7 6	5 2 6	5 2 6	5 0 0	5 0 0	5 0 0	5 0 0	5 7 6	5 10 0	5 5 5
1898	5 10 0	5 8 9	5 8 9	5 10 0	5 16 3	5 18 9	5 17 6	6 0 0	6 2 6	6 5 0	6 10 0	6 15 0	5 18 6½
1899	6 15 0	7 0 0	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 12 6	7 12 6	7 12 6	7 12 6	8 0 0	7 6 5½
1900	8 0 0	8 0 0	8 2 6	8 5 0	8 7 6	8 7 6	8 7 6	8 0 0	8 0 0	8 0 0	7 10 0	7 0 0	8 0 0
1901	6 15 0	6 15 0	6 5 0	6 0 0	6 0 0	6 0 0	6 0 0	6 5 0	6 7 6	6 5 0	6 0 0	6 0 0	6 4 4
1902	5 17 6	5 12 6	5 15 0	5 15 0	5 15 0	5 15 0	5 15 0	5 15 0	5 15 0	5 15 0	5 15 0	5 10 0	5 14 7½
1903	5 10 0	5 10 0	5 15 0	6 0 0	6 0 0	6 0 0	5 12 0	5 12 6	5 12 6	5 12 6	5 12 6	5 10 0	5 13 11
1904	5 7 6	5 10 0	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 11 10
1906	5 15 0	5 17 6	5 17 6	5 17 6	5 17 6	5 17 6	5 17 6	6 17 6	6 0 0	6 10 0	7 0 0	7 0 0	6 2 3½
1906	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 10 0	7 0 10½
1907	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 0 0	7 0 0	7 8 4
1908	6 10 0	6 10 0	6 10 0	6 5 0	6 5 0	6 5 0	6 0 0	6 0 0	6 0 0	6 0 0	6 0 0	6 0 0	6 3 9
1909	6 0 0	6 0 0	6 0 0	6 0 0	6 0 0	5 15 0	5 15 0	5 15 0	6 0 0	6 0 0	6 0 0	6 0 0	5 18 9
1910	6 5 0	6 5 0	6 7 6	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 15 0	6 15 0	6 15 0	6 10 2
1911	6 15 0	6 15 0	6 15 0	6 15 0	6 15 0	6 15 0	6 15 0	6 15 0	6 15 0	6 15 0	6 15 0	6 18 4	6 15 3½
1912	7 3 9	7 5 0	7 5 0	7 12 6	7 15 0	7 15 0	7 15 0	8 0 0	8 0 0	8 0 0	8 2 0	8 5 0	7 14 10
1913	8 5 0	8 5 0	8 5 0	8 5 0	8 5 0	8 5 0	8 5 0	7 19 0	7 15 0	7 3 0	6 15 0	6 10 0	7 16 5½
1914	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 0 0	6 0 0	7 0 0	7 5 0	7 5 0	7 6 3	7 10 0	6 14 8½
1915	8 0 0	8 10 0	9 0 0	9 10 0	9 10 0	10 0 0	10 0 0	10 0 0	10 0 0	10 0 0	10 5 0	11 0 0	9 12 11
1916	11 7 6	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 9 2
1917	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0
1918	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0
1919	11 10 0	14 0 0	14 0 0	14 0 0	17 0 0	17 7 6	17 15 0	18 5 0	18 5 0	18 5 0	19 12 6	21 5 0	16 15 5
1920	22 10 0	23 10 0	23 10 0	23 10 0	23 10 0	23 10 0	23 10 0	23 10 0	24 0 0	24 10 0	24 5 0	24 5 0	23 13 4
1921	23 5 0	22 10 0	20 4 0	19 0 0	19 0 0	17 0 0	15 0 0	14 15 0	13 12 0	12 5 0	10 10 0	10 10 0	16 9 3
1922	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 0 0	9 7 6	9 4 0	9 5 0	9 5 0	9 5 0	9 18 4½
1923	9 7 6	9 15 0	10 5 0	10 10 0	10 10 0	10 10 0	9 18 9	9 17 6	9 17 6	9 17 6	9 18 6	10 6 10½	10 1 2½
1924	10 1 6	9 18 1½	9 17 6	9 17 6	9 17 6	9 19 4½	10 5 0	10 5 0	10 5 0	9 19 0	9 15 0	9 15 0	9 19 7½
1925	9 14 0	9 10 0	9 10 0	9 1 3	9 0 0	9 0 0	8 17 0	8 13 1½	8 7 6	8 5 6	7 16 3	7 14 3	8 15 8½
1926	7 12 2½	7 12 6	7 12 6	7 14 4½	7 15 0	7 16 10½	8 2 6	8 2 6	8 4 0	8 12 6	8 12 6	8 16 3	8 1 1½
1927	8 17 6	8 17 6	8 11 6	8 7 6	8 6 3	8 5 0	—	—	—	—	—	—	8 10 10½

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